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PAGE'S WEEKLY

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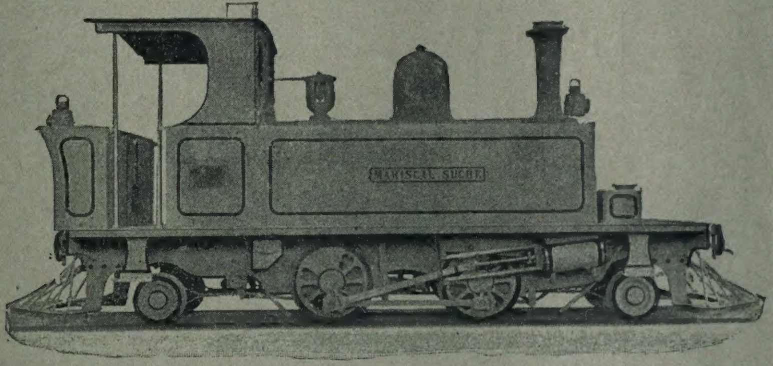
RAILWAY FOUNDRY LEEDS.

LOCOMOTIVE ENGINES,

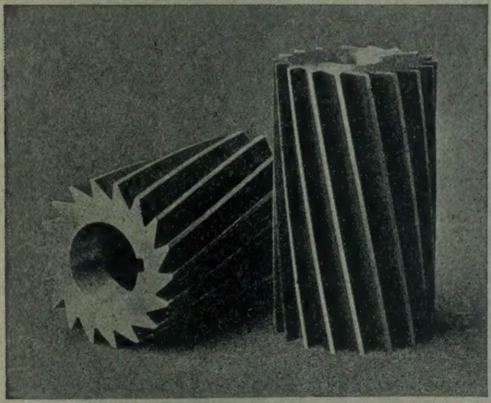
Of all sizes and any gauge of Railway, of greatly improved Construction, for Main or Branch Railways, Contractors, Ironworks, Collieries. Prices, Photographs, and full Specifications on application.



SOLE MAKERS OF THE "RODGERS" PULLEYS (Registered).

Wrought Iron throughout, Rim, Arms, and Boss.

ALSO "ETCHELLS'" NON-DRIP BEARINGS, SHAFTING, AND ACCESSORIES.



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High Speed
or
Ordinary Steel.

E. G. WRIGLEY & CO., Ltd.,
Foundry Lane Works,
SOHO, BIRMINGHAM.

PATENT PAPER PINIONS

FOR NOISELESS MOTOR DRIVES.

MACHINE-CUT GEARS

OF ALL DESCRIPTIONS.

THE REID GEAR CO.,
Linwood, PAISLEY.

IN EVERY SIZE FOR
HAND OR POWER
USE

HACK SAW

CHARLES BAYNES

BLADES

The Sole Product of a Factory.

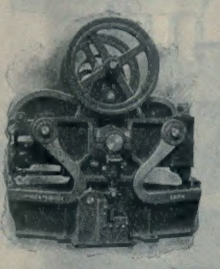
Best English Steel throughout

WORKS:
KNUZDEN BROOK
·BLACKBURN·

PAGE'S WEEKLY Miscellaneous

Mr. G. H. HUGHES, M.I.Mech.E.,
Consulting and Organising Engineer for Water Works and Industrial Undertakings,
97, QUEEN VICTORIA ST., LONDON, E.C.
Telephone No.: 5754 Bank. Write for particulars.

ED. BRAND, *MECHANICAL ENGINEER,* 35, SHAKESPEARE STREET, MANCHESTER.
Modern Wire-Working Machinery.
Such as for Rolling, Drawing, Weaving, Netting, Forming, Automatic Straightening and Cutting, Cabling, Testing, &c.
Inquiries Solicited. Teleg. Address: "Filieres, Manchester."



PUNCHING & SHEARING Machines.
STEAM HAMMERS.
Shipbuilders' MACHINE TOOLS.
DAVIS & PRIMROSE,
Leith Ironworks, EDINBURGH.

WEST PASCAGOULA CREOSOTING WORKS,
WEST PASCAGOULA, MISS., U.S.A.
Situated on Pascagoula Bay and on the line of the Louisville and Nashville Railroad. These works have been in operation for more than twenty-six years. ORDERS for Creosoted Piles, Telegraph Poles, Cross Arms, Electric Conduits, Paving Blocks, Sawed Tiles, and Timber PROMPTLY EXECUTED. New cylinders, 115 ft. long. Capacity, one million feet per month. A.B.C. Code used. Cable address: Pierre, West Pascagoula, Miss.—Address, JNO. B. LINDSEY, Superintendent.

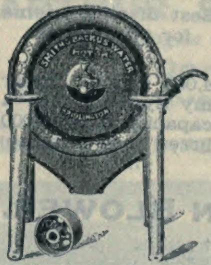
GRAHAM, MORTON & Co., LTD.
Head Office and Works, LEEDS.
Makers and Erectors of all Classes of
CONVEYING PLANTS, COAL HANDLING PLANTS, AERIAL ROPEWAYS, &c., &c.

SHONE PNEUMATIC EJECTORS
FOR RAISING SEWAGE, SLUDGE, WATER, &c.
Air Compressing Machinery
FOR ALL SERVICES.
HUGHES & LANCASTER
47, VICTORIA STREET, LONDON, S.W.

PAGE & ROWLINGSON,
Chartered Patent Agents.
Mr. PAGE, who is a Whitworth Exhibitioner and an Associate Member of the Institute of Civil Engineers, has had a large experience as a Practical Mechanical Engineer, and is specially qualified to deal with the most intricate mechanical problems successfully. *Write for Handbook of Information Free.*
28, NEW BRIDGE STREET, LONDON, E.C.,
And 14, St. Ann's Square, Manchester.

'McINNES-DOBBIE' INDICATORS.
In Two types: External and Enclosed Pressure Springs.
Each made in several forms and sizes to suit all speeds and pressures.
Special Indicators for Gas, Winding, and Ammonia Engines, and for Motor-Cars.
DOBBIE, McINNES, LIMITED,
45, BOTHWELL ST., GLASGOW.
Adopted by the British, French, and Japanese Admiralties.

WAYGOOD LIFTS
APPLY FOR CATALOGUE.
FALMOUTH ROAD, LONDON, S.E.



CHEAP POWER.
SMITH'S
Backus Water Motors
1/16 to 10 H.P.
Will drive any class of Machinery, and work on 15 lb. pressure.
ERIC S. A. SMITH, ENGINEER,
APPLY FOR CATALOGUE. BRIDLINGTON.

BABCOCK & WILCOX, Ltd.
PATENT WATER-TUBE BOILERS.
These Boilers are in use throughout the world to the extent of 4,700,000 h.p. generating steam for all purposes, and fired with all kinds of fuel.
See our Advertisement appearing Sept. 1st, page 37.
HEAD OFFICES—Oriel House, Farringdon Street, LONDON, E.C.
WORKS—Renfrew, SCOTLAND.

FORTUNES IN WASTE
FIRE WOOD AND LIGHTER MACHINERY
M. GLOVER & CO., Patentees, LEEDS.

Standard of the World.
J. H. WILLIAMS & CO.,
Drop-forgings only.
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PAGE'S WEEKLY Miscellaneous

THE BRITISH ADVERTISER SERVICE BUREAU,

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Specialises in Advertising for Engineers.
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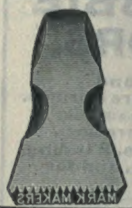

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Sets of Letter and Figure Punches, Seals, Embossing Presses and Dies, Brass Name Plates, Stencil Plates, Moulders' Letters and Figures.

Brass Labels, and Time Checks.

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68, West Street, SHEFFIELD.

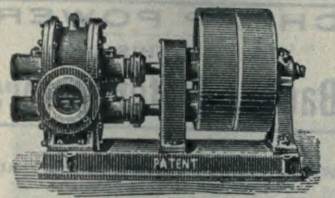
BRETT'S PATENT LIFTER Co., LTD.
COVENTRY, ENG.

Speciality—

FORGING PLANT.

See our Advertisement appearing Sept. 1st.
SEND FOR LATEST CATALOGUE.

ENKE'S ROTATIVE PUMP



Best of all Systems for all Liquids.

4,000 Pumps under my System (with a capacity up to 15,000 litres per minute) in use.

ENKE'S PRECISION BLOWER.

Entirely of Iron without packing for high pressures to 0·3 atm.

CARL ENKE, Schkeuditz-Leipzig, GERMANY.

J. TOMEY & SON'S
EUREKA GAUGE GLASS
ESTABLISHED 1853
ASTON
BIRMINGHAM.

A NEW GAUGE GLASS.
Samples, Lists, and Testimonials on application.

"S.H.P."

Tested to 350 lb. Steam Pressure. **For High Pressure Boilers.**

WALTER SCOTT, LTD.,

LEEDS STEEL WORKS, LEEDS, ENGLAND.

MANUFACTURERS OF . . .

Rolled Steel Joists, Channels, etc.
Mild Steel Blooms, Billets, Slabs, Tinbars, Rounds and Flats.
Speciality: TRAMRAILS.

CAST-IRON

COLUMNS,

STANCHIONS AND GIRDERS.

Head, Wrightson & Co., Thornaby, Stockton-on-Tees.

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Speed
RECORDERS.

For further particulars . . of our . .

TIME RECORDERS

see our whole page Ad. on Sept. 1st.

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MESSRS. ELLIOTT & FRY

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ONLY ADDRESS :—
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Telegrams: PHOTICS, LONDON.
Telephone: 293 PADDINGTON.

Electric Hauling GEARS

Main and Tail Main Rope, Endless Rope and Portable, Hoisting, and Hauling Gears.

M. B. WILD & CO., 35 and 36, Clarence Chambers, Corporation Street,
BIRMINGHAM.

PAGE'S WEEKLY Miscellaneous

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Blue Planished and Glazed Steel Sheets for Lagging

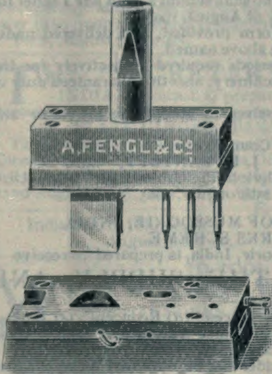
and Covering generally.

ZEITZ & Co., 21, Lime St., London, E.C.

DO YOU WANT ANY

Press Tools, Jigs, Cutters, Rimers, Gauges?

If so, send your requirements, and



A. FENGL & CO., ALTRINCHAM,

will submit design and price.

Inventors' Models Worked Out and Manufactured.

STAMPINGS TO THE TRADE.

Telegrams: "Fengl, Altrincham."

TRANSPORTERS.

See our Advertisement appearing Sept. 1st.

TEMPERLEY TRANSPORTER CO.,

72, Bishopsgate Street Within, LONDON, E.C.

Telephone: 365 London Wall. Telegrams: "Transumo."

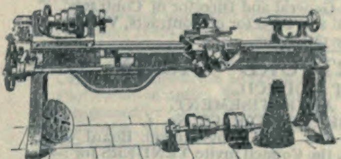
Refuse Destructors.

Write for particulars to:—

HEENAN & FROUDE, Limited,

4, Chapel Walks, MANCHESTER.

Works: MANCHESTER and WORCESTER.



HIGH-CLASS MACHINE TOOLS

In stock for immediate delivery.

THOS. W. WARD, Lᴰ.

Albion Works, SHEFFIELD.

Our Modelled Designs TALK! We can prove it!

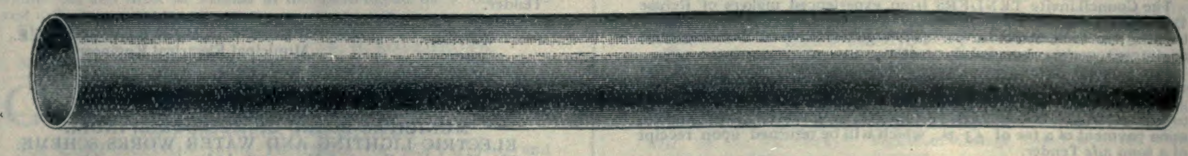
ARTHUR STAFFORD & CO.,

Catalogue and Half-Tone Printers,

Denton, MANCHESTER.

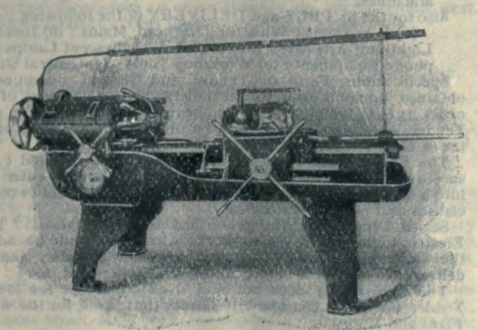
See our Advertisements in last and next week's Issues.

WELDED AND RIVETED STEEL PIPES.



THOMAS PIGGOTT & CO., LTD., SPRING HILL, BIRMINGHAM. **Send for Catalogue.**

HARTNESS FLAT TURRET LATHE



The only Turret Lathe with Cross-Sliding Head.

JONES & LAMSON MACHINE CO.,

"JUBILEE BUILDINGS,"

97, Queen Victoria Street, LONDON.

RIVETS, BOLTS, & SCREWS

Of all Descriptions and for all Purposes.

SEND FOR CATALOGUE.

T. D. ROBINSON & CO., Ltd., DERBY.

MACHINE TOOLS,

Special & General

For Engineers, Shipbuilders, Boiler Makers, Girder Makers, and Bridge Builders.

G. F. SMITH, LIMITED,

South Parade,

HALIFAX.

Telegrams: "Radial, Halifax."

PAGE'S WEEKLY Contracts

CONTRACTS.

SEALED TENDERS WILL BE RECEIVED at this Office up to 11 a.m. on Friday, August 25th next, for

PROVIDING A REFUSE DESTRUCTOR FOR THE POOR HOUSE.

Tenders received after the said date and hour will not be considered.

Tenders are to be accompanied with a deposit of £5, to be made in the office of the Crown Agents by tenderers residing in Great Britain, not having a representative in Malta, and in this office by local tenderers.

The tenderer whose offer is accepted shall be held to have bound himself to an agreement, and may be compelled to carry out the obligations arising from his Tender, even though he may not have signed a formal contract.

The Government does not bind itself to accept the lowest or any Tender.

Particulars, Specifications, &c., may be obtained on application at this office, or to the Crown Agents for the Colonies, Whitehall Gardens, London.

JOS. HUBER,
Acting Receiver-General and Director of Contracts.

Office of the Receiver-General and Director of Contracts, Valletta,
July 18th, 1905.

BISHOP'S STORTFORD URBAN DISTRICT COUNCIL.

AMENDED ADVERTISEMENT.

SEWAGE WORKS.—CONTRACT No. 1.

Subject to the sanction of the Local Government Board being obtained to the necessary loans, the Council invite TENDERS for :—

Supplying and Fixing Gas Pumping Engine, Suction Gas Plant and Sewage Pumps at their Sewage Pumping Station.

Specification and Form of Tender can be obtained on application to the undersigned.

The person or firm whose Tender is accepted will be required to enter into a written contract, and to provide two eligible sureties.

Sealed Tenders, endorsed "Tender for Pumping Engine," to be sent to me, the undersigned, by 4 o'clock p.m. on Tuesday, September 12th, 1905.

The Council do not bind themselves to accept any Tender.

By order,
THOS. SWATHERIDGE,
Clerk to the Council.

Council Offices, 7, North Street, Bishop's Stortford,
July 21st, 1905.

MERTHYR TYDFIL URBAN DISTRICT COUNCIL.

REFUSE DESTRUCTOR PLANT.

The Council invite **TENDERS** from experienced makers of Refuse Destructor Plant for the **ERECTION** of **PLANT** capable of effectually burning 120 tons of refuse per day, together with all buildings and contingent works connected therewith.

The Council have selected three alternative sites, and copies of the site plans, together with "General Conditions and Particulars for the guidance of Contractors tendering," may be obtained upon application to T. FLETCHER HARVEY, Esq., Engineer and Surveyor to the Council, upon payment of a fee of £3 3s., which will be returned upon receipt of a *bona fide* Tender.

The Council do not bind themselves to accept the lowest or any Tender.

Sealed Tenders, endorsed "Destructor Plant," must be delivered to T. Aneuryn Rees, Esq., Clerk to the Council, on or before September 1st, 1905.

T. FLETCHER HARVEY,
Engineer and Surveyor to the Council.

Town Hall, Merthyr Tydfil,
June 16th, 1905.

COUNTY BOROUGH OF WOLVERHAMPTON.

TETTENHALL PUMPING STATION EXTENSIONS.

CONTRACT No. 2.

The Corporation of Wolverhampton are prepared to receive **TENDERS** for a **VERTICAL TRIPLE-EXPANSION PUMPING ENGINE** and **OTHER WORK** connected therewith from engine builders who will undertake to pay the rate of wages and observe the hours of labour recognised and agreed upon between the Trades Unions and the Employers respectively in the locality in which the work is to be performed, or such a rate of wages or hours as are equivalent or approximate thereto.

A copy of the Specification and Form of Tender may be obtained from Mr. E. A. B. WOODWARD, Waterworks Engineer, Town Hall, Wolverhampton, upon payment of the sum of Five Pounds, which amount will be returned to every engine builder who submits a *bona fide* Tender, but not otherwise.

Each Tender must be enclosed in a sealed cover addressed to "The Chairman of the Water Committee," and endorsed "Pumping Machinery," and delivered at my office on or before Friday, the 1st day of September next.

The right to decline the lowest or any Tender is reserved to the Corporation.

HORATIO BREVITT,
Town Clerk.

Town Hall, Wolverhampton,
July 4th, 1905.

SELBY URBAN DISTRICT COUNCIL.

NEW WATERWORKS.

PUMPING MACHINERY.—CONTRACT No. 6.

TENDERS are hereby invited for the **CONSTRUCTION, DELIVERY,** and **ERECTION** of **DUPLICATE PUMPING MACHINERY** in connection with the above works, comprising Boilers, Triple-expansion Engines, Surface Condensers, Force Pumps, Head Gear, and Borehole Pumps, with a capacity equal to raising 32,000 gallons per hour under a head of 310 ft.

Copies of the Plans and Specifications will be supplied on application to the Engineers, Mr. PERCY GRIFFITH, M.Inst.C.E., 54, Parliament Street, Westminster, S.W., and Mr. BRUCE McGREGOR GREY, Assoc. M.Inst.C.E., Council Offices, Selby, Yorkshire, on payment of £5, which will be returned to all contractors who shall submit a *bona fide* Tender for the work on or before the 28th day of August, 1905.

Tenders must be made on the form provided, and delivered under seal to the undersigned by the date above named.

Every Tender must state the periods required respectively for the delivery and the erection of the machinery, also the guaranteed duty of the engines.

The Council do not bind themselves to accept the lowest or any Tender.

By order of the Council,
(Signed) J. H. BANTOFT,
Clerk to the Urban District Council.

Council Offices, Selby, dated the 25th of July, 1905.

MUNICIPAL BOARD OF MUSSOORIE, INDIA.

WATER WORKS SCHEME.

The Municipal Board of Mussoorie, India, is prepared to receive

TENDERS FOR THE SUPPLY AND DELIVERY of the following :—

(*a*) Pipes; (*b*) Tees; (*c*) Cross Pieces; (*d*) Reducers; (*e*) Bends; (*f*) Bends and Collars; (*g*) Sluice Valves and Stop Cocks; (*h*) Ball and Non-return Valves.

Specifications and Form of Tender can be obtained on application to the undersigned, on payment of a deposit of Rs. 45 (£3), which amount will be returned on receipt of a *bonâ fide* Tender. Additional copies may be obtained on payment of a further fee of Rs. 3 (4s.) each, which will not be returned.

The firm whose Tender is accepted will be required to deposit the sum of Rs. 1500 (£100) in a bank, and the receipt, endorsed in favour of the Chairman, must be forwarded with the Tender. This amount will be forfeited on the failure of the Tenderer to execute a formal contract bond within two months of the acceptance of his Tender.

Sealed Tenders, on the prescribed form, endorsed "Tender for Water Works Scheme," should be addressed to the Chairman, Municipal Board, Mussoorie, India, and must be delivered to him on or before Monday, October 9th, 1905.

The Municipality does not bind itself to accept the lowest or any Tender.

By order, C. H. SHANAN,
Assoc. M.Inst.C.E., A.M.I.E.E., A.M.I.Mech.E.,
Municipal Electrical Engineer.

Municipal Office, Mussoorie, U.P., India,
June 14th, 1905.
Telegraphic Address: "Shanan, Mussoorie."

MUNICIPAL BOARD OF MUSSOORIE, INDIA.

ELECTRIC LIGHTING AND WATER WORKS SCHEME.

The Municipal Board of Mussoorie, India, is prepared to receive

TENDERS FOR THE SUPPLY, DELIVERY, and ERECTION at sites, in complete working order, of the following plant :—

(*a*) Steel Power Pipes; (*b*) Water Motors; (*c*) Alternators with Exciters; (*d*) Switchboards with Instruments and Apparatus; (*e*) Transformers; (*f*) Induction Motors; (*g*) Pumps; (*h*) Workshop Machines.

Also for the SUPPLY and DELIVERY of the following :—

(*a*) Bare Copper Wire for Overhead Mains; (*b*) Insulators and Lightning Arresters; (*c*) Arc and Incandescent Lamps; (*d*) Telephone Equipment; (*e*) Workshop Tools; (*f*) General Stores.

Specifications, Form of Tender, and General Conditions can be obtained on application to the undersigned on payment of a deposit of Rs. 75 (£5), which amount will be returned on receipt of a *bona fide* Tender. Additional copies may be obtained on payment of a further fee of Rs. 5 (6s. 8d.) per set, which will not be returned.

The Firm whose Tender is accepted will be required to find two sureties to the satisfaction of the Municipality, and to enter with them into a contract to be prepared by the Municipality, and to contain such clauses as it may think necessary.

Sealed Tenders, on the prescribed form, endorsed "Tender for Electric Lighting and Water Works Scheme," should be addressed to the Chairman, Municipal Board, Mussoorie, India, and must be delivered to him on or before Monday, October 23rd, 1905.

The Municipality does not bind itself to accept the lowest or any Tender, nor will it consider any Tender that is not for the whole of the Plant and Material.

By order,
C. H. SHANAN,
Assoc. M.Inst.C.E., A.M.I.E.E., A.M.I.Mech.E.,
Municipal Electrical Engineer.

Municipal Office, Mussoorie, U.P., India,
June 14th, 1905.
Telegraphic Address: "Shanan, Mussoorie."

PAGE'S WEEKLY Contracts and Appointments Open

NORTH-EASTERN RAILWAY.—TO CONTRACTORS.—The DIRECTORS are prepared to receive TENDERS for the CONSTRUCTION and ERECTION of the NEW STEEL SWINGBRIDGE over the River Hull at Sculcoates, on their Victoria Dock Branch, and weighing about 460 tons. The Contract will include the Removal of the existing Swingbridge, the Raising of the Public Road, and the Building of River Walls, Timber Jetty, &c. Plans may be seen, and Specification, detailed Lists of Quantities, and Forms of Tender obtained, on personal application at the office of Mr. W. J. CUDWORTH, the Company's Engineer, at York, on and after August 14th, 1905. The Directors do not bind themselves to accept the lowest or any Tender. Sealed Tenders, marked "Tenders for the Reconstruction of the Swingbridge at Sculcoates," to be sent to the Secretary at York not later than noon on Monday, September 11th, 1905.

York, August 3rd, 1905. R. L. WEDGWOOD, Secretary.

THE SECRETARY OF STATE FOR INDIA in Council is prepared to receive TENDERS from such persons as may be willing to supply :—

PLATE GIRDER SPANS, of 30 ft., 40 ft., and 60 ft.

The conditions of contract may be obtained on application to the Director-General of Stores, India Office, Whitehall, S.W., and Tenders are to be delivered at that office by 2 o'clock p.m., on Tuesday, the 22nd August, 1905, after which time no Tender will be received.

E. GRANT BURLS,
Director-General of Stores.

India Office, Whitehall,
August 9th, 1905.

TO TOOL MAKERS.

WITTY AND WYATT, LIMITED, require TENDERS for the following TOOLS for repairing shop :—

TWO LATHES, self-acting and screw-cutting, with approximate dimensions as follows :—

Centres	12 in.
High in the gap	18½ in.
Width of gap in front of universal face plate after taking out the bridge	10½ in.
Width of table	15 in.
Length to turn	11 ft. 6 in.
Length of table	15ft. 6 in.

Complete with driving gear, change wheels, bell and universal 4-jaw chuck, plates, &c.

ONE LATHE, of half the dimensions above, complete with driving gear, change wheels, bell and universal chuck, &c.

THREE SHAPING MACHINES, best quality, self-acting 10-in. stroke.

Tenders, with drawings, must be in duplicate, one copy without any names on, and must be handed to the undersigned on or before the 21st inst.

The prices must include packing and delivery at c.f.i. Genoa.

F. H. LOVEGROVE,
Secretary.

88, Leadenhall Street, London, E.C.

COUNTY BOROUGH OF SOUTHAMPTON.

TO ENGINEERS AND OTHERS.

The CORPORATION invite TENDERS for SUPPLYING and FIXING at the Corporation Wharf, Chapel, three 18-in. HIGH-PRESSURE DIRECT-ACTING CENTRIFUGAL PUMPING ENGINES, including all Suction and Delivery Pipes, Steam and other connections.

Particulars may be obtained upon application to Mr. J. A. CROWTHER, A.M.Inst.C.E., Borough Engineer, Market Chambers, 123, High Street, Southampton.

Sealed Tenders, endorsed "Tender for Pumping Engines," must be delivered at my office before 2 p.m. on Monday, the 4th September next.

No pledge is given to accept the lowest or any Tender.

By order,
R. R. LINTHORNE,
Town Clerk.

Town Clerk's Office, Municipal Offices, Southampton,
July 21st, 1905.

NORTHWICH RURAL DISTRICT COUNCIL.

BARNTON SEWERAGE and SEWAGE DISPOSAL WORKS.

The Rural District Council of Northwich are prepared to receive TENDERS for the CONSTRUCTION of SEPTIC TANKS, BACTERIAL FILTERS, STORM WATER FILTER, and Auxiliary Works, at Barnton, together with about 1,800 lineal yards of 12-in. and 9-in. Stoneware Sewers, with Manholes, Pump Well, Syphon Chambers, etc.

Plans can be seen and copies of specification and bill of quantities obtained from the Engineer, Mr. W. M. BECKETT, Assoc.M.Inst.C.E., 33, Brazennose Street, Manchester, on deposit of one guinea, which sum will be returned on receipt of a *bona fide* Tender and the return of all documents lent to the Contractor for the purpose of making up his Tender.

Sealed Tenders, endorsed "Barnton Sewerage," to be deposited with me by 12 o'clock noon on Thursday, August 24th, 1905.

J. ERNEST FLETCHER,
Clerk to the Rural District Council.

Northwich.

APPOINTMENTS OPEN.

APPOINTMENT OF COUNTY SURVEYOR.

DERBYSHIRE COUNTY COUNCIL.

The Council invites APPLICATION for the POST of COUNTY SURVEYOR at a salary of £500 per annum, rising by annual increments of £25 to £600. No pension.

The Surveyor shall devote the whole of his time to the duties of the office, and shall have the entire charge of all roads and bridges under the care and control of the County Council. He shall supervise and report on the work of the district surveyors and of the Local Authorities who have claimed to repair their main roads whether under contract or not. He shall attend all necessary meetings, and shall prepare such plans, estimates, and reports as may be required.

The Surveyor must have a thorough practical knowledge of the making and maintaining of roads, of the different materials employed, of the best methods of using steam rollers, and of the management of roadmen, and no testimonials will be considered unless the applicant can show he possesses these qualifications.

The Council will provide offices, clerical assistance, and stationery, and an ample allowance for travelling will be made, but this will be arranged with the Surveyor after his appointment.

The Surveyor must also carry out any further duties that the Council may require from time to time.

The appointment will be made subject to determination on three months' notice by either side.

Canvassing directly or indirectly will disqualify.

Particulars of duties, &c., can be obtained from, and all applications, accompanied by copies of three recent testimonials (originals will not be returned), must be sent on or before the 6th day of September, 1905 to the undersigned.

N. J. HUGHES-HALLETT,
Clerk of the County Council.

County Offices, Derby.

WATER OF LEITH PURIFICATION AND SEWERAGE COMMISSIONERS.

APPOINTMENT OF ENGINEER.

A duly qualified CIVIL ENGINEER is REQUIRED by the Commissioners to devote his whole time to the Superintendence of the Engineering Work involved in the management of their system, and the carrying out of their Acts of Parliament.

Salary, £200 per annum.

Applications will be received by the Commissioners' Clerk, H. INGLIS LINDSAY, W.S., 16, Queen Street, Edinburgh, up to and including the 21st day of August, 1905.

Each application must be accompanied by twelve copies of testimonials.

Further particulars may be obtained from the Clerk.

Edinburgh, August 4th, 1905.

THE GLASGOW AND WEST OF SCOTLAND TECHNICAL COLLEGE.

The Governors invite APPLICATIONS for the PROFESSORSHIP in the DEPARTMENT of ENGINEERING in this College, vacant by the appointment of Professor Watkinson to the Chair of Engineering in the University of Liverpool. Salary £500.

Applications, with testimonials, must be sent not later than August 21st, to the SECRETARY, Technical College, Glasgow, from whom further information may be obtained.

THE WESTERN VALLEYS (MON.) SEWERAGE BOARD.

CONSTRUCTION OF MAIN TRUNK SEWER.

INSPECTORS OF WORKS REQUIRED.

The Western Valleys (Mon.) Sewerage Board propose to appoint several INSPECTORS at a salary of £2 10s. per week, to superintend under the engineers and resident engineer, the carrying out of their main sewerage works, and invite APPLICATIONS from persons who have had experience in similar works.

Applications, sealed and endorsed "Inspector of Works," must be on forms to be obtained from me, accompanied by not more than three recent testimonials, and must reach me not later than 10 a.m. on Monday, the 21st August, 1905.

Canvassing, either directly or indirectly, will disqualify.

T. S. EDWARDS,
Clerk to the Board.

24, Stow Hill, Newport (Mon.),
July 29th, 1905.

CRAWFORD MUNICIPAL TECHNICAL INSTITUTE, CORK.

WANTED, a TEACHER of MECHANICAL ENGINEERING at a salary of £200 per annum. Whitworth Scholar preferred. He will be expected to teach mechanical engineering, theory and practical work in laboratory, workshop practice in a fully equipped workshop and smithy, machine construction and drawing office work, mathematics and steam.

Further particulars of duties can be obtained from E. A. O'KEEFE, B.E., M.I.E.E., with whom applications must be lodged on or before Thursday, August 31st.

Canvassing will disqualify.

By order of the Committee,
F. B. GILTINAN, Secretary.

Emmet Place, Cork, August 1st, 1905.

BUYERS' DIRECTORY.

NOTE.—*The display advertisements of the firms mentioned under each heading can be found readily by reference to the Alphabetical Index to Advertisers on pages 23 and 25.*

In order to assure fair treatment to advertisers, each firm is indexed under its leading speciality ONLY.

Advertisers who prefer, however, to be entered under two or more different sections can do so by an annual payment of 5s. for each additional section.

Advertisers' Service Bureau.
British Advertiser Service Bureau, Queen Anne's Chambers, Westminster, S.W.

Artesian Well Machinery.
John Z. Thom, Patricroft, Manchester.

Belting.
Binney & Son, Catherine Street, City Road, London, E.C.
Cort, Arthur, & Co., Camberwell, London, S.E.
Fleming, Birkby & Goodall, Ltd., West Grove, Halifax.
Gilmour, W. & O., St. John's Hill, Edinburgh.

Boilers.
Clayton, Son & Co., Ltd., Leeds City Boiler Works, Leeds.
Grantham Crank & Iron Co., Ltd., Grantham.

Boilers (Water-tube).
Babcock & Wilcox, Ltd., Oriel House, Farringdon Street, London, E.C.
Stirling Boiler Co., Ltd., Motherwell, N.B.

Bolts, Nuts, Rivets, etc.
Herbert W. Periam, Ltd., Floodgate Street Works, Birmingham.
T. D. Robinson & Co., Ltd., Derby.

Books.
Crosby Lockwood & Son, Stationers' Hall Court, London, E.C.
Griffin, Charles, & Co., Exeter Street, Strand, W.C.
New Zealand Mines Record, Wellington, New Zealand.
Spon, E. & F. N., 125, Strand, W.C.

Boring Machines.
Asquith, William, Ltd., Well Road Works, Halifax.
Niles-Bement-Pond Co., 23-25, Victoria Street, London, S.W.

Case-Hardening Compounds.
Hy. Miller & Co., Millgarth Works, Leeds.

Castings.
Ashmore, Benson, Pease & Co., Ltd., Stockton-on-Tees.

Catalogues, Printing, &c.
Atlantic Press, Ltd., Weymouth Street, Manchester.
Spottiswoode Advertising Agency, Clun House, Surrey Street, Strand, W.C.
Stafford, Arthur, & Co., Denton, Manchester.

Chucks.
Fairbanks Co., 78-80, City Road, London, E.C.

Cisterns, Tanks, &c.
Ashmore, Benson, Pease & Co., Ltd., Stockton-on-Tees.
F. A. Keep, Juxon & Co., Barn Street, Birmingham.

Clutches (Friction).
David Bridge & Co., Castleton Ironworks, Rochdale, Lancashire.

Colliery Plants.
Graham, Morton & Co., Ltd., Leeds.

Condensing Plant.
Benn, Sykes, Haslingden, near Manchester.
Concentric Condenser, Ltd., 23, Northumberland Avenue, London, W.C.
Mirrlees-Watson & Co., Ltd., Glasgow.

Consulting Engineers.
Gibbs, John, & Son, 80, Juke Street, Liverpool.
G. H. Hughes, A.M.I.M.E., 97, Queen Victoria Street, London, E.C.
Melville & Macalpine, 615, Walnut Street, Philadelphia, Pa., U.S.A.

Continental Railway Arrangements.
Northern Railway of France.
South Eastern & Chatham Railway Co.

Conveying and Elevating Machinery.
Adolf Bleichert & Co., Leipzig-Gohlis, Germany.
Fraser & Chalmers, Ltd., 3, London Wall Buildings, London, E.C.
Graham, Morton & Co., Ltd., Leeds.
Temperley Transporter Co., 72, Bishopsgate Street Within, London, E.C.

Coverings (Boiler).
Magnesia Coverings, Ltd., Washington Station, co. Durham.

Cranes, Travellers, Winches, etc.
Joseph Booth & Bros. Ltd, Rodley, Leeds.
Thomas Broadbent & Sons, Ltd., Huddersfield.
Niles-Bement-Pond Co., 23-25, Victoria Street, London, S.W.

Cranks.
Clarke's Crank & Forge Co., Ltd., Lincoln, England.

Cutters (Milling).
Pratt & Whitney Co., 23-25, Victoria Street, London, S.W.
E. G. Wrigley & Co., Ltd., Foundry Lane Works, Soho, Birmingham.

Destructors.
Heenan & Froude, 4, Chapel Walks, Manchester.
Horsfall Destructor Co., Ltd., Armley, Leeds.

Dredges and Excavators.
Delange & Cie, Mce., Hoboken, near Antwerp.
Rose, Downs & Thompson, Ltd., Old Foundry, Hull.

Drilling Machines.
Asquith, William, Ltd., Well Road Works, Halifax.
Niles-Bement-Pond Co., 23-25, Victoria Street, London, S.W.
Swift, George, Claremont Ironworks, Halifax.

Economisers.
E. Green & Son, Ltd., Manchester.

Ejectors (Pneumatic).
Hughes & Lancaster, 47, Victoria Street, London, S.W.

Electrical Apparatus.
Allgemeine Elektricitäts Gesellschaft, Berlin, Germany.
Broadbent, T. W., Victoria Electrical Works, Huddersfield.
Crypto Electrical Co., 3, Tyer's Gateway, Bermondsey Street, London, S.E.
Gent & Co., Ltd., Faraday Works, Leicester.
Greenwood & Batley, Ltd., Albion Works, Leeds.
India Rubber, Gutta Percha, and Telegraph Works Co., Ltd., Silvertown, London, E.
Mather & Platt, Ltd., Salford Iron Works, Manchester.
Matthews & Yates, Ltd., Swinton, Manchester.
Mix and Genest, Berlin, W., Germany.
Nalder Bros. & Thompson, 34, Queen Street, London, E.C.
New Gutta Percha Co., Ltd., Dashwood House, New Broad Street, E.C.
Newton Brothers, Full Street, Derby.
Phœnix Dynamo Manufacturing Co., Bradford, Yorks.
Sturtevant Engineering Co., Ltd., 147, Queen Victoria Street, London, E.C.
Turner, Atherton & Co., Ltd., Denton, Manchester.
B. Weaver & Co., 22, Rosoman Street, Clerkenwell, London, E.C.

Engineers' Supplies.
Ahlers, Ad., Whitley Bay, near Newcastle-on-Tyne.

Engines (Gas).
Campbell Gas Engine Co., Ltd., Halifax
Soest, L., & Co., Ltd., 114-116, Victoria Street, London, S.W.

Engines (Electric Lighting).
McLaren, J. and H., Midland Engine Works, Leeds.

Engines (Locomotive).
Baldwin Locomotive Works, Philadelphia, Pa., U.S.A.
Hunslet Engine Co., Ltd., Leeds, England.
Hudswell, Clarke & Co., Ltd., Leeds, England.
McLaren, J. & H., Midland Engine Works, Leeds.

Engines (Portable).
Garrett, R., & Sons, Leiston, R.S.O., Suffolk.

Engines (Stationary).
Allis-Chalmers Co., 533, Salisbury House, Finsbury Circus, London, E.C.
Fraser & Chalmers, Ltd., 3, London Wall Buildings, London, E.C.
Garrett, R., & Sons, Leiston, R.S.O., Suffolk.
Mirrlees Watson Co., Ltd., Glasgow.

Engines (Traction).
Jno. Fowler & Co. (Leeds), Ltd., Steam Plough Works, Leeds.
Garrett & Sons, Ltd., Richard, Leiston, R.S.O., Suffolk.

Engravers.
Jno. Swain & Son, Ltd., 58, Farringdon Street, London, E.C.

Exhaust Steam Oil Separators.
Lancaster & Tonge, Ltd., Pendleton, Manchester.

Fans, Blowers.
Capel Fan Co., 13, Moseley Street, Newcastle-on-Tyne.
Davidson & Co., Ltd., "Sirocco" Engineering Works, Belfast, Ireland.
Gibbs, John & Son, 80, Juke Street, Liverpool.
James Keith & Blackman Co., Ltd., 27, Farringdon Avenue, London, E.C.
Matthews & Yates, Ltd., Swinton, Manchester.

Fire Bricks.
J. H. Sankey & Son, Ltd., Essex Wharf, Canning Town, London, E

PAGE'S WEEKLY Mining Ropes

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Steel Wire Mining Ropes.

Wire Ropes for Hauling and Winding Gear,
and all operations connected with Mining.

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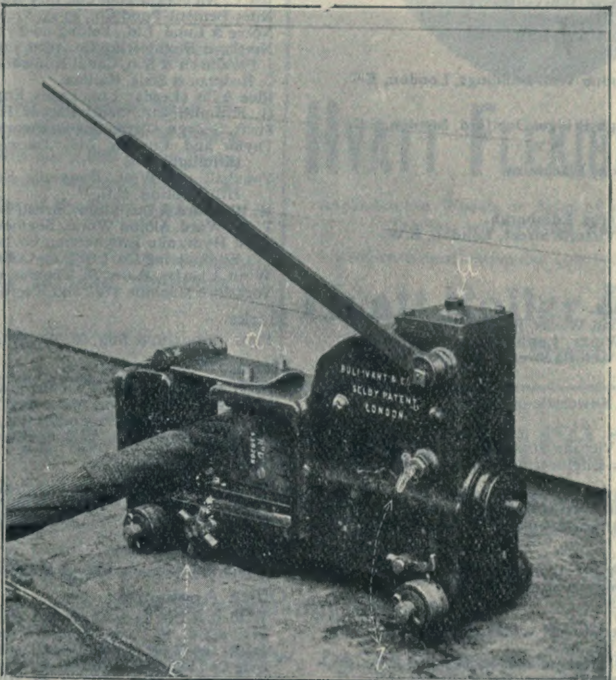
LIFT ROPES,

HAULING ROPES,



BLOCKS,

PULLEYS,

CRAB WINCHES,

AND ALL WIRE ROPE APPLIANCES.

Patent Hydraulic Rope-Cutting Machine (SELBY PATENT)

With this Machine a man can cut up to 9-in. circ. wire rope without assistance in about one minute.

RAPID. SIMPLE. PORTABLE. LABOUR SAVING.

Prices and all Particulars on application to Sole Manufacturers :—

BULLIVANT & CO., Ltd., Works: MILLWALL, E.

Telephone No.: 239 EASTERN.

Buyers' Directory—(*Continued*).

Firewood Machinery.
M. Glover & Co., Patentees and Saw Mill Engineers, Leeds.

Fountain Pens.
Mabie, Todd & Bard, 93, Cheapside, London, E.C.

Forging (Drop) Plants.
Brett's Patent Lifter Co., Ltd., Coventry.

Forgings (Drop).
J. H. Williams & Co., Brooklyn, New York, U.S.A.

Furnaces.
Deighton's Patent Flue & Tube Company, Vulcan Works, Pepper Road, Leeds.
Leeds Forge Co., Ltd., Leeds.
Masons Gas Power Co., Ltd., Alma Works, Levenshulme, Manchester.

Gas Producers.
Graham, Morton & Co., Ltd., Leeds.
Masons Gas Power Co., Ltd., Alma Works, Levenshulme, Manchester.

Gauge Glasses.
J. B. Treasure & Co., Vauxhall Road, Liverpool.
Tomey, J., & Sons, Aston, Birmingham.

Gauges (Pressure, Vacuum, and Hydraulic).
Dobbie, McInnes, Ltd., 45, Bothwell Street, Glasgow.

Gearing.
Ahlers, Ad., Whitley Bay, near Newcastle-on-Tyne.
Asquith, William, Ltd., Well Road Works, Halifax.
Reid Gear Co., Linwood, near Glasgow.
Wild, M. B., & Co., Corporation Street, Birmingham.

Gold Dredging Plant.
Fraser & Chalmers, Ltd., 3, London Wall Buildings, London, E.C.

Greases.
Blumann and Stern, Ltd., Plough Bridge, Deptford, London, S.E.

Hack Saws.
Baynes, Charles, Knuzden Brook, Blackburn.

Hammers (Steam).
Davis & Primrose, Leith Ironworks, Edinburgh.
Niles-Bement Pond Co., 23-25, Victoria Street, London, S.W.

Hoisting Machinery.
See Conveying Machinery.

Horizontal Boring Machines.
Asquith, William, Ltd., Well Road Works, Halifax.
Greenwood & Batley, Albion Works, Leeds.
Niles-Bement Pond Co., 23-25, Victoria Street London, S.W.

Hydraulic Leather.
Ahlers, Ad., Whitley Bay, near Newcastle-on-Tyne.

Hydraulic Machine Tools.
Niles-Bement-Pond Co., 23-25, Victoria Street, London, S.W.
Vauxhall and West Hydraulic Engineering Co. Ltd., 23, College Hill, London, E.C.

Icemaking and Refrigerating Machinery.
H. J. West & Co., 114-118, Southwark Bridge Road, London, S.E.

Indicators.
Dobbie McInnes, Ltd., 45, Bothwell Street, Glasgow.
Hannan & Buchanan, 75, Robertson Street, Glasgow.

Iron and Steel.
Allen, Edgar, & Co. Ltd., Imperial Steel Works, Sheffield.
Askham Bros. & Wilson, Ltd., Sheffield.
Consett Iron Co., Ltd., Consett, Durham, and Newcastle-on-Tyne.
Fairley & Sons, James, Old Mint, Shadwell Street, Birmingham.
Farnley Iron Co., Ltd., Leeds England.
Fried. Krupp. Grusonwerk, Magdeburg-Buckau, Germany.
J. Frederick Melling, 14, Park Row, Leeds, England.
Parker Foundry Co,, Derby.
Purden, John & Sons, Lambhill Forge, by Maryhill, Glasgow.
Walter Scott, Ltd., Leeds Steel Works, Leeds, England.
Gilbert Thompson & Co., 116, Victoria Street, London, S.W.

Ironwork (Constructional).
F. A. Keep, Juxon & Co., Barn Street, Birmingham.

Ironwork (Galvanised).
F. A. Keep, Juxon & Co., Barn Street, Birmingham.

Lagging Sheets.
Zeitz & Co., 21, Lime Street, London, E.C.

Lathes.
Asquith, William, Ltd., Well Road Works, Halifax.
Bradbury & Co., Ltd., Wellington Works, Oldham.
Eclipse Tool Manufacturing Co., Linwood, near Glasgow.
Leckenby, Benton, & Co., Perseverance Ironworks, Halifax.
Mitchell, D., & Co., Ltd., Central Ironworks, Lawkholme, Keighley.
Niles-Bement-Pond Co., 23-25, Victoria Street, London, S.W.
Northern Engineering Co. (1900) Ltd., King Cross, near Halifax.
Swift, George, Claremont Ironworks, Halifax.

Lathe Carriers.
Williams, J. H., & Co., Brooklyn New York, U.S.A.

Laundry Machinery.
W. Summerscales & Sons, Ltd., Engineers, Phœnix Foundry, Keighley, England.

Lifts.
Waygood & Co., Ltd., Falmouth Road, London, S.E.

Lubricants.
Blumann & Stern, Ltd., Plough Bridge, Deptford, London, S.E.
Reliance Lubricating Oil Co., The, 19 & 20, Water Lane, Great Tower Street, London, E.C.
Matthew Wells & Co., Hardman Street Oil Works, Manchester.

Machine Tools.
Asquith, William, Ltd., Well Road Works, Halifax.
George Addy & Co., Waverley Works, Sheffield.
Bateman's Machine Tool Co., Hunslet, Leeds.
Bertrams, Ltd., St. Katherine's Works, Sciennes, Edinburgh.
Bradbury & Co., Ltd., Wellington Works, Oldham.
Breuer, Schumacher & Co., Ltd., Kalk, near Cologne-on-Rhine (Germany).
Cunliffe & Croom, Ltd., Broughton Ironworks, Manchester.
Dean, Smith & Grace, Ltd., Keighley.
Fengl, A., & Co., Grafton Street, Altrincham.
Greenwood & Batley, Ltd., Leeds.
Jones & Lamson Machine Co., 97, Queen Victoria Street, London, E.C.
John Lang & Sons, Johnstone, near Glasgow.
Luke & Spencer, Ltd., Broadheath, Manchester.
Mitchell, D., & Co., Ltd., Central Ironworks, Lawkholme, Keighley.
Jos. C. Nicholson Tool Co., City Rd. Tool Wks., Newcastle-on-Tyne.
Niles-Bement-Pond Co., 23-25, Victoria Street, London, S.W.
Noble & Lund Ltd., Felling-on-Tyne.
Northern Engineering Co., 1900, Ltd., King Cross, near Halifax.
J. Parkinson & Son, Canal Ironworks, Shipley, Yorkshire.
C. Redman & Sons, Halifax.
Rice & Co. (Leeds), Ltd., Leeds, England.
G. F. Smith, Ltd., South Parade, Halifax.
Swift, George, Claremont Ironworks, Halifax.
Taylor and Challen, Ltd., Derwent Foundry, Constitution Hill, Birmingham.
Vauxhall and West Hydraulic Engineering Co., Ltd., 23, College Hill, London, E.C.
H. W. Ward & Co., Lionel Street, Birmingham.
T. W. Ward, Albion Works, Sheffield.
West Hydraulic Engineering Co. (see Vauxhall and West Hydraulic Engineering Co. Ltd.), 23, College Hill, London, E.C.
Winn, Charles, & Co., St. Thomas Works, Birmingham.
Yorkshire Machine Tool and Engineering Works, Liversedge, Yorks.

Marks.
Pryor, Edward, & Son, 68, West Street, Sheffield.

Metals.
Delta Metal Co., Ltd., East Greenwich, London, S.E.
Magnolia Anti-Friction Metal Co., Ltd., of Great Britain, 49, Queen Victoria Street, London, E.C.
Phosphor Bronze Co., Ltd., Southwark, London, S.E.

Metals (Perforated).
W. Barns & Son, Chalton Street, Euston Road, London, N.W.
Brown, Andrew, & Co., 110, Cannon Street, London, E.C.
Méguin, Fr., & Co., Ltd., Engineering Works, Dillingen-on-Saar.

Mining Machinery.
Fraser & Chalmers, Ltd., 3, London Wall Buildings, London, E.C.

Office Appliances.
Halden & Co., J., 8, Albert Square, Manchester.
Hall & Co., B. J., 39, Victoria Street, London, S.W.
Inglesant, T., & Sons, Ltd., Atlas House, Leicester.
Lyle Co., Ltd., Harrison Street, Gray's Inn Road, London, W.C.
Rockwell-Wabash Co., Ltd., 69, Milton Street, London, E.C.
Shannon, Ltd., Ropemaker Street, London, E.C.
Trading and Manufacturing Co., Ltd., Temple Bar House, Fleet Street, London, E.C.

Oils, &c.
Blumann and Stern, Ltd., Plough Bridge, Deptford, London, S.E.
Valor Co., Ltd., Rocky Lane, Aston Cross, Birmingham.
Wells, M., & Co., Hardman Street Oil Works, Manchester.

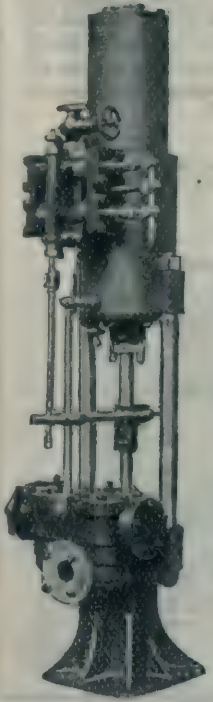
Packing.
Beldam Packing & Rubber Co., 93-94, Gracechurch Street, London, E.C.
Frictionless Engine Packing Co., Ltd., Hendham Vale Works, Harpurhey, Manchester.
Lancaster & Tonge, Ltd., Pendleton, Manchester.
Redfern & Co., S., Swan Lane, New Brown Street, Manchester.
Quaker City Rubber Co., Coronation House, Lloyd's Avenue, E.C.
United States Metallic Packing Co., Ltd., Bradford,
J. Bennett von der Heyde, 6, Brown Street, Manchester.

Paper.
Lepard & Smiths, Ltd., 29, King Street, Covent Garden, London, W.C.

Patent Agents.
Page & Rowlingson, 28, New Bridge Street, London, E.C.

PAGE'S WEEKLY Miscellaneous

J. P. HALL & SONS,
Ltd.,
ENGINEERS,
PETERBOROUGH.



We make a SPECIAL Compound Direct Acting Slow Running

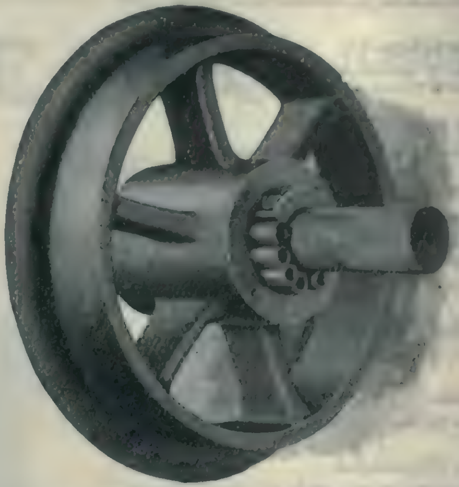
Boiler Feed Pump

ECONOMICAL AND EFFICIENT.

We deliver 100 lbs. of Water for the expenditure of 1 lb. of Steam. This with our 2,000 gallon Pump, and a much higher efficiency as the size of the Pump increases.

AN IDEAL PUMP FOR GENERAL BOILER FEEDING PURPOSES.

APPLY FOR PARTICULARS.



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Applied to the Wheels or Axles of Mine Tubs, Bogies, Cranes, and Trollies, will save **33 per cent. of power.**

Require little attention and cost little. Sent on approval.

Hyatt Roller Bearing Co.,
47, Victoria Street, LONDON, S.W.

Sankey's Fire Bricks and Fire Cements.

Every Description of FIRE-CLAY GOODS. *STOCK UNEQUALLED.*

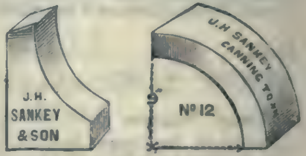
VARIOUS BRANDS.

"CASTLE CARY."
SANKEY
LONDON.E.

Engineers' Designs made to Order of the best Fire-resisting Materials.

WRITE FOR NEW CATALOGUE.

SANKEY'S SEATERS AND COVERS.



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In Machines and Structures, with Examples in Graphic Statics,

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"Fulfils its purpose in a straightforward, practical, and unassuming manner. The author has a sound knowledge of what is required to be imparted and a happy way of imparting it."—*Examiner.*

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CONSTRUCTIONAL STEELWORK.

Being Notes on the Practical Aspect and the Principles of Design, together with an Account of the Present Methods and Tools of Manufacture.

By A. W. FARNSWORTH, A.M.I.M.E.

"Well illustrated . . . and the work will be found of value to all architects and engineers engaged in steelwork construction."—*Building News.*

A Prospectus of either of the above sent Post Free on Application.
London: CHARLES GRIFFIN & CO., LTD., EXETER STREET, STRAND, W.C.

Buyers' Directory—(*Continued*).

Photo Copying Frames.

J. Halden & Co., 8, Albert Square, Manchester.
B. J. Hall & Co., 39, Victoria Street, London, S.W.

Photographers.

Booker & Sullivan, 67 and 69, Chancery Lane, W.C.
Elliott & Fry, 55, Baker Street, London, W.

Pinch Bars.

Samson & Co., Garforth, near Leeds.

Pipe Wrenches (Chain).

Williams, J. H., & Co., Brooklyn, New York, U.S.A.

Pistons.

Lancaster & Tonge, Ltd., Pendleton, Manchester.

Planished Sheets.

Zeitz & Co., 21, Lime Street, London, E.C.

Porcelain.

Gustav Richter, Charlottenburg, near Berlin, Germany.

Presses (Hydraulic).

Greenwood & Batley, Albion Works, Leeds
Niles-Bement-Pond Co., 23-25, Victoria Street, London, S.W.

Publishers.

Crosby Lockwood & Son, 7, Stationers' Hall Court, London, E.C.
Charles Griffin & Co., Ltd., Exeter Street, Strand, London, W.C.
Spon, E. and F. N., 125, Strand, W.C.
New Zealand Mines Record, Wellington, New Zealand.

Pumps and Pumping Machinery.

Drum Engineering Co., 27, Charles Street, Bradford.
Enke, Carl, Schkeuditz-Leipzig, Germany.
Fairbanks, Morse & Co., 126, Southwark Street, London, S.E.
Fraser & Chalmers, Ltd., 3, London Wall Buildings, London, E.C
J. P. Hall & Sons, Ltd., Peterborough.
Hathorn, Davey & Co., Ltd., Leeds, England.
Positive Rotary Pumps, Ltd., 23, Northumberland Avenue, London, W.C.
Tangyes, Ltd., Cornwall Works, Birmingham.

Radial Drilling Machines.

Asquith, William, Ltd., Well Road Works, Halifax.
Greenwood & Batley, Albion Works, Leeds.
Niles-Bement-Pond Co., 23-25, Victoria Street, London, S.W.
Northern Engineering Co. (1900), Ltd., King Cross, near Halifax.
Swift, George, Claremont Ironworks, Halifax.

Rails.

Wm. Firth, Ltd. Leeds

Railway Wagons.

Nye, A. W., 110, Cannon Street, London, E.C.
W. R. Renshaw & Co., Ltd., Phœnix Works, Stoke-on-Trent

Riveted Work.

F. A. Keep, Juxon & Co., Forward Works, Barn Street, Birmingham.

Roller Bearings.

Hyatt Roller Bearing Co., 47, Victoria Street, London, S.W.

Roofs.

D. Anderson & Son, Ltd., Lagan Felt Works, Belfast.
Graham, Morton & Co., Ltd., Leeds.
Head, Wrightson & Co., Ltd., Thornaby-on-Tees.

Ropeways (Aerial).

Bullivant & Co., Ltd., 72, Mark Lane, London, E.C.

Scientific Instruments.

Cambridge Scientific Instrument Co., Ltd. Cambridge.

Spanners.

Williams, J. H., & Co., Brooklyn, New York, U.S.A.

Stampings.

Thomas Smith & Sons of Saltley, Ltd., Birmingham.
Williams, J. H., & Co., Brooklyn, New York, U.S.A.

Stamps (Rubber).

Rubber Stamp Co., 1 & 2, Holborn Buildings, Broad Street Corner Birmingham.

Stamps (Metal).

Edward Pryor & Son, 68, West Street, Sheffield.

Steam Traps.

British Steam Specialties, Ltd., Fleet Street, Leicester.
Lancaster & Tonge, Ltd., Pendleton, Manchester.

Steam Wagons.

Thornycroft & Co., Ltd., J. I., Chiswick, London, W.
Yorkshire Patent Steam Wagon Co., Pepper Road, Hunslet, Leeds.

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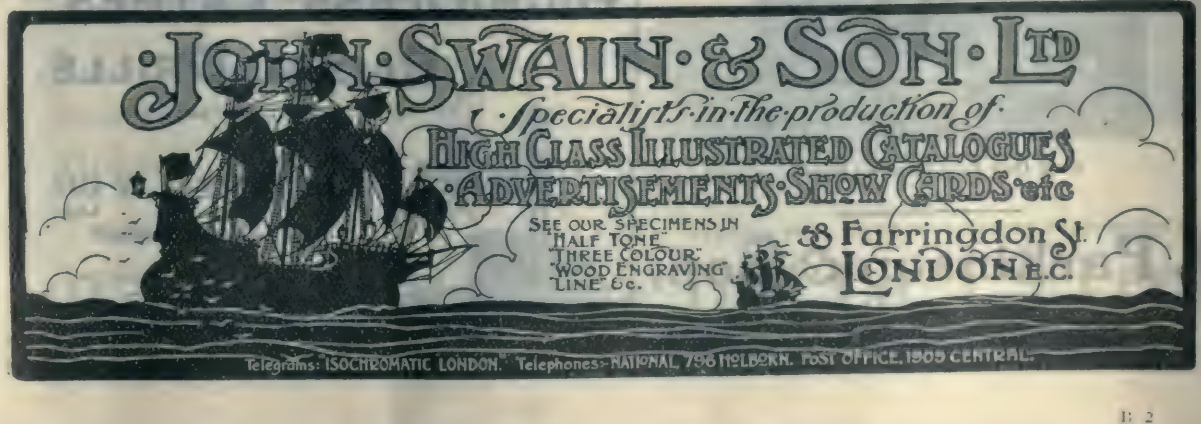

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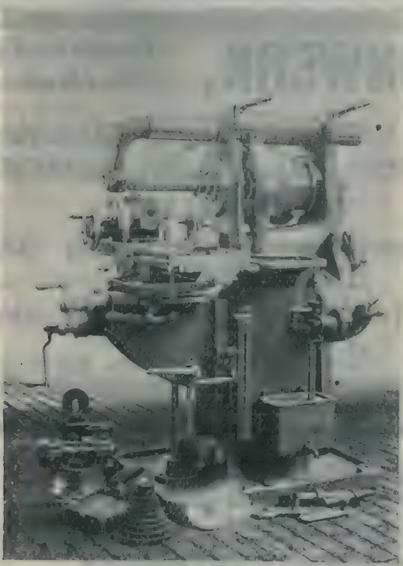

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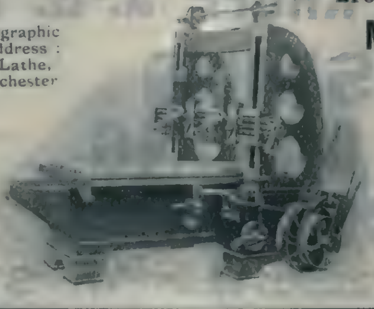

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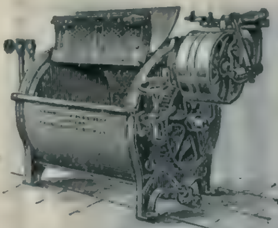

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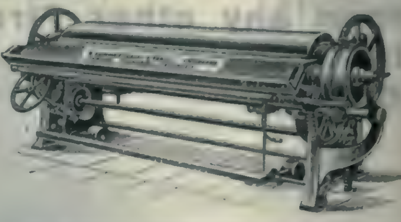

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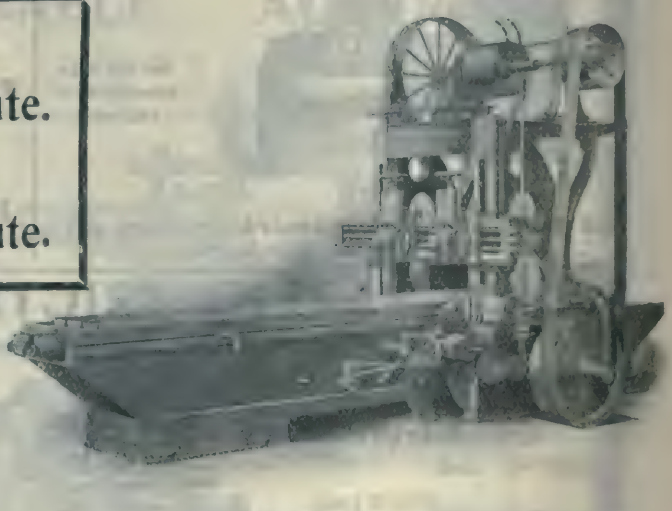

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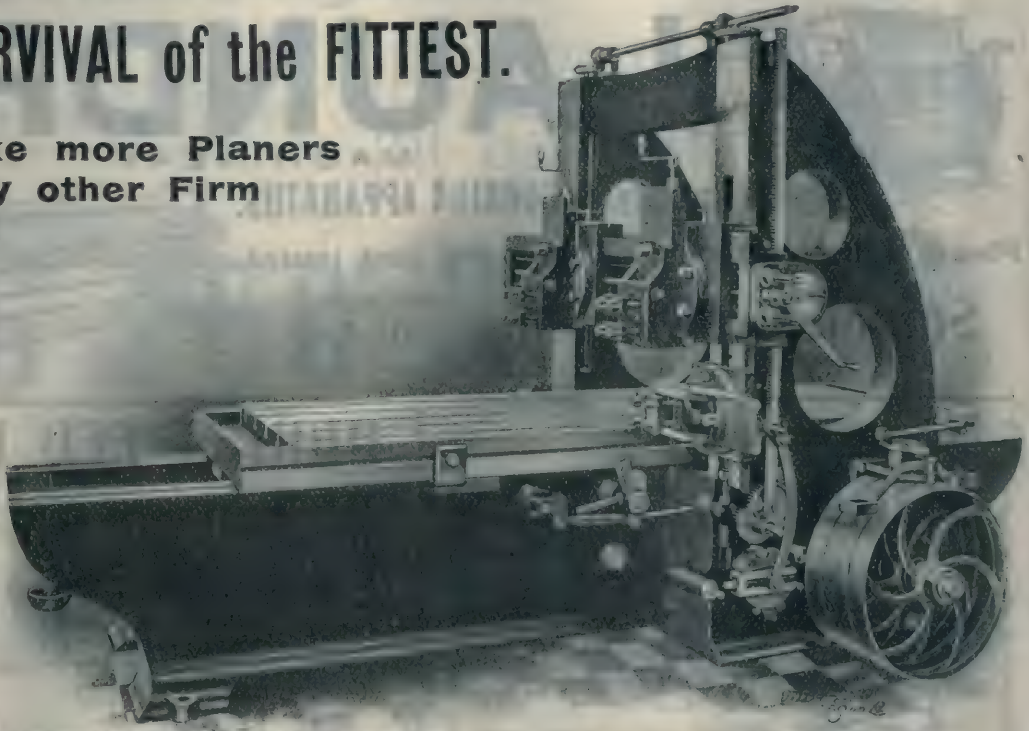

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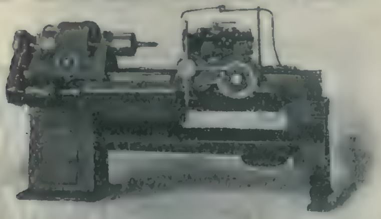

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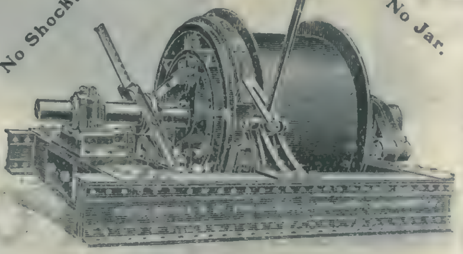

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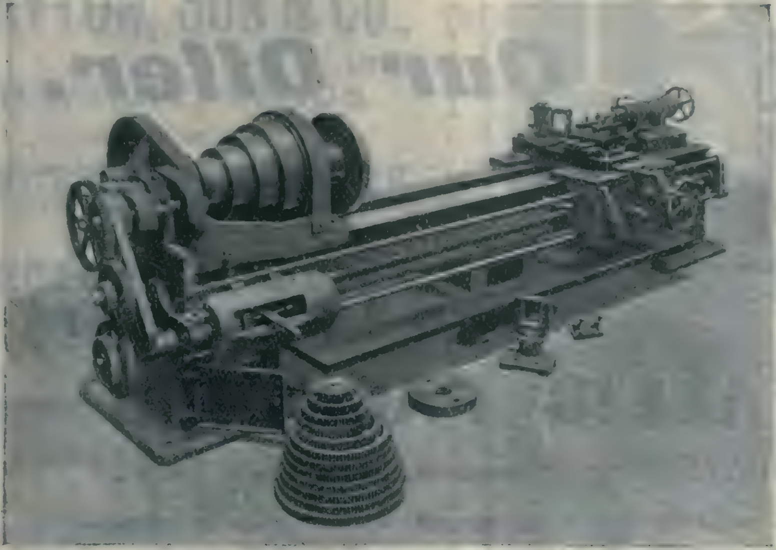

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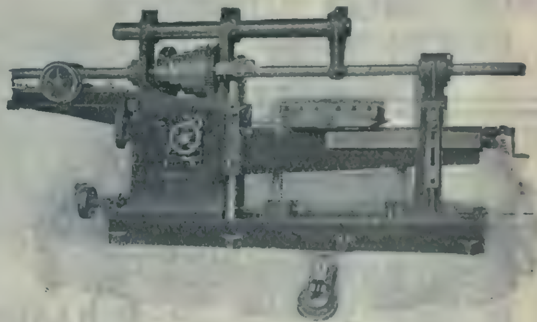

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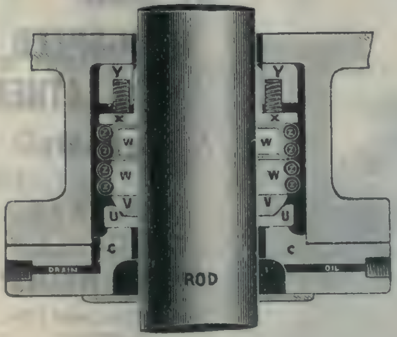

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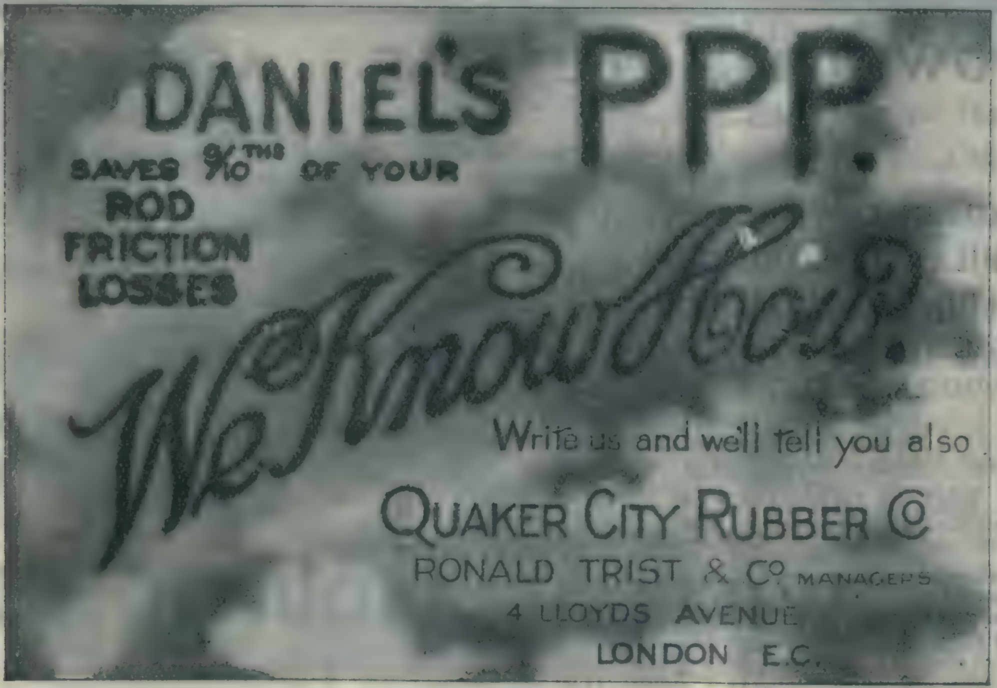

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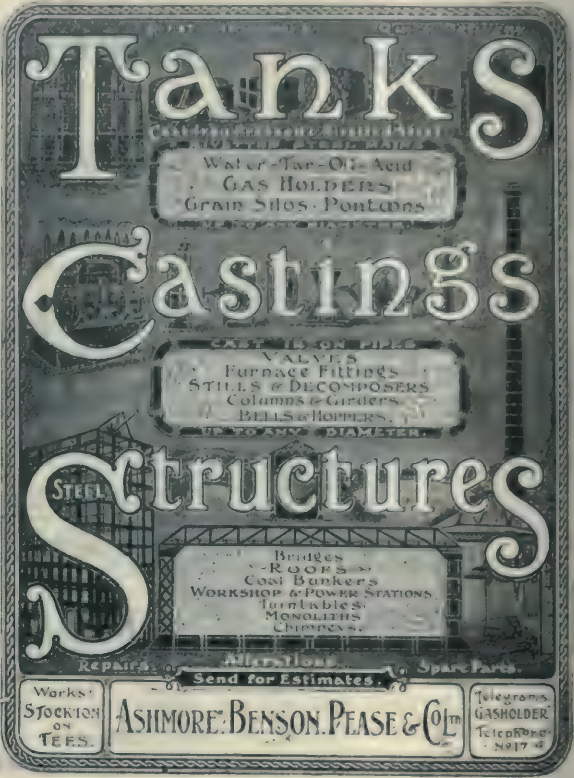

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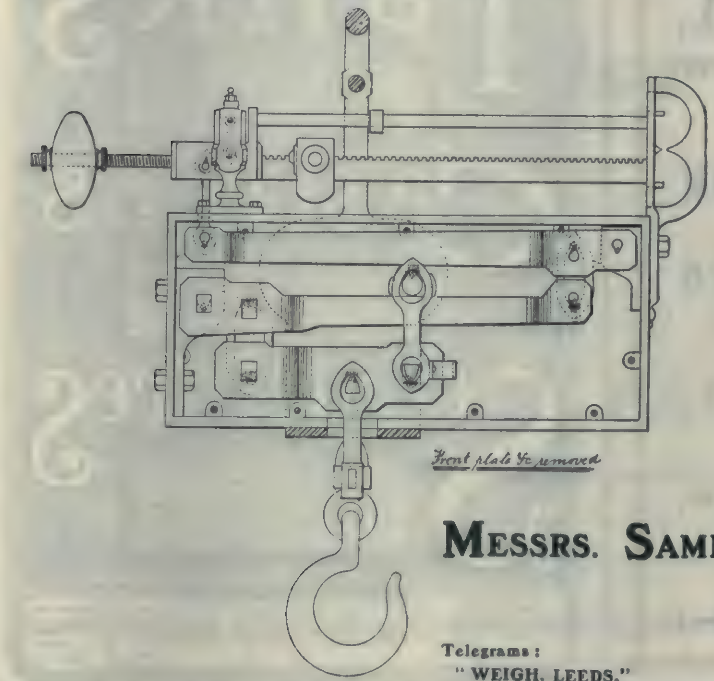

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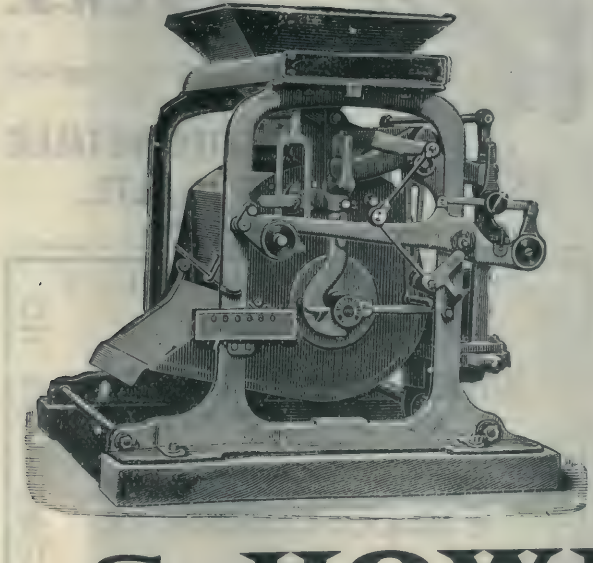

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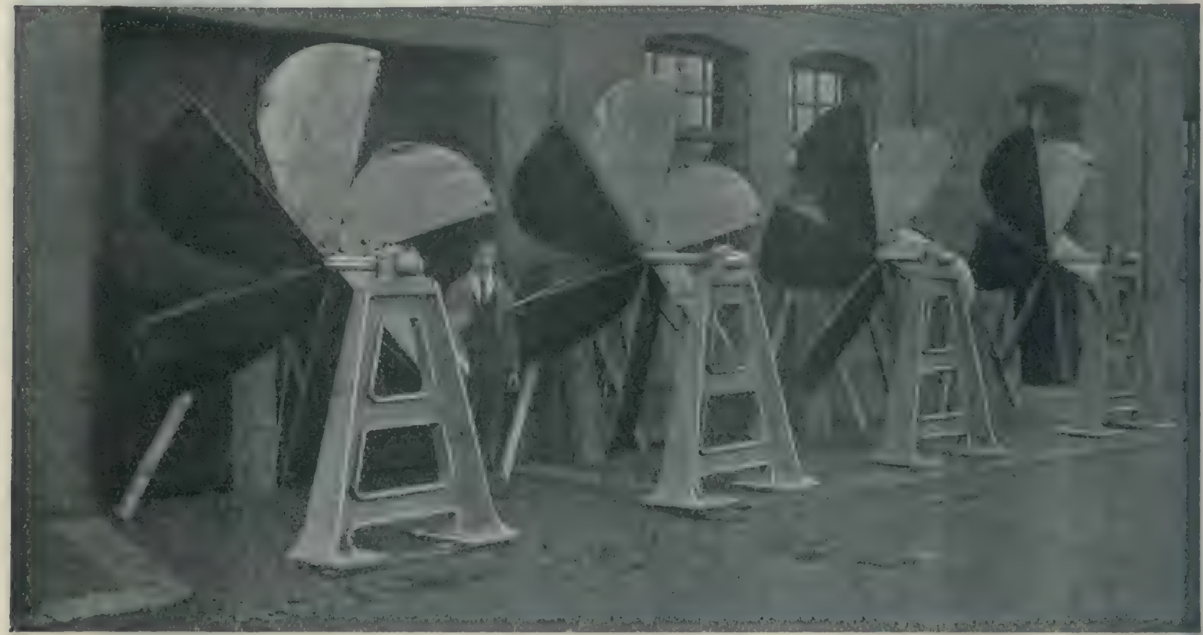

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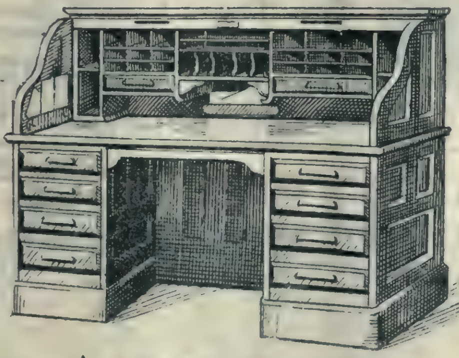

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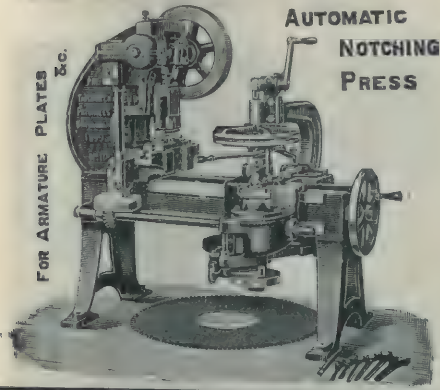

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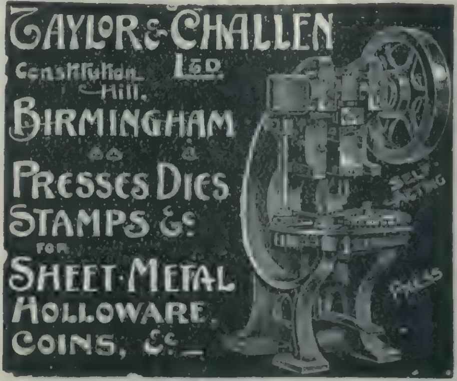

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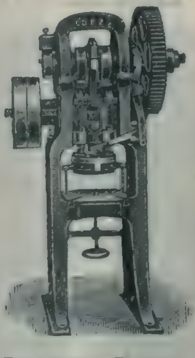

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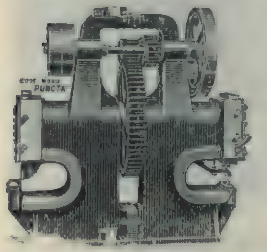

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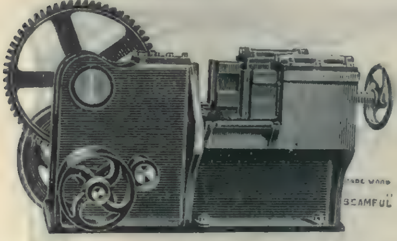

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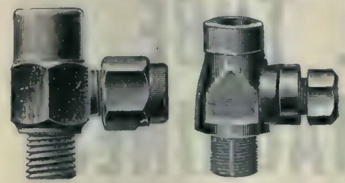

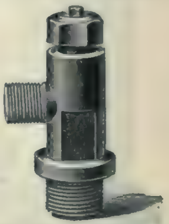

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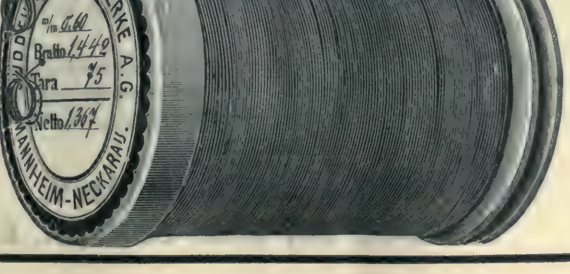

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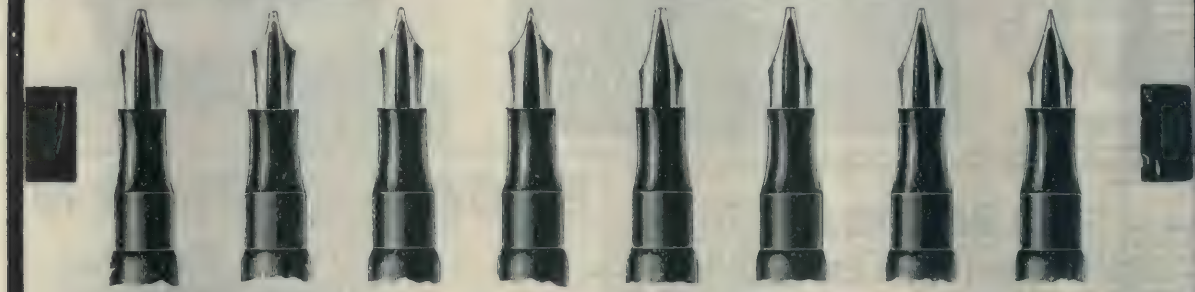

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PAGE'S WEEKLY

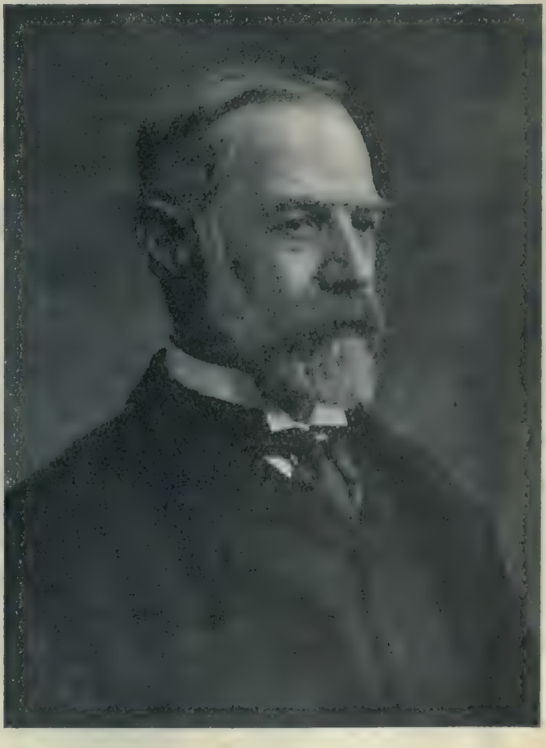
An Illustrated Technical Weekly, dealing with the Engineering, Electrical, Mining, Iron and Steel, and Shipbuilding Industries.

VOL. VII. LONDON, FRIDAY, AUGUST 18, 1905. NO. 49.

The Offices of "Page's Weekly," Wednesday Evening.

THE South African meeting of the British Association opened at Cape Town yesterday, when the first portion of the presidential address was delivered by Professor G. H. Darwin, whose portrait appears on this page. The president pointed out that until ten years ago the essential diversity of the chemical elements was accepted by the chemist as an ultimate fact. The recent electrical researches of Lenard, Röntgen, Bacquerel, the Curies, and of Thomson, had shown that the element was not indivisible, and a flood of light had been thereby thrown on the ultimate constitution of matter.

The President went on to deal with the latest atomic theory which resolves the atom into a globe charged with positive electricity, inside which there are thousands of corpuscles of negative electricity revolving in regular orbits with great velocities, the corpuscles mutually repelling each other, but being all attracted by the globe containing them. The President rightly claimed the investigation which demonstrated this as a real triumph of mathematical power. The President pursued to its end the history of the model atom in which investigators have imitated the properties of matter. He pointed out that the laws which govern electricity in motion indicate that such an atom must be radiating or losing energy, and that therefore a time must come when it will run down like a clock, and in the end spontaneously transmute itself into an element which needed less energy than was required in the former state.



Photo, Elliott & Fry.

PROFESSOR G. H. DARWIN, F.R.S., LL.D., D.SC.

President of the British Association, who delivered the first part of his presidential address at Cape Town on Tuesday.

DARTFORD IRONWORKS—MESSRS. T. AND E. HALL, LTD.—VIEW OF MACHINE SHOP.

A VIEW IN THE TURNERS' SHOP. (*See page* 349.)

Such a conclusion, is as Professor Darwin pointed out, an absolute contradiction of all that was known of the elements until recently; but there is nevertheless good reason to believe that in radium and in other elements possessing very complex atoms, we do actually observe that break-up and spontaneous rearrangement which constitute a transmutation of elements. It is impossible to say how far science will penetrate into the avenue thus opened up, but it is obvious that the extension of knowledge in this direction must ultimately profoundly affect the material side of human life, however remote it may at present seem from everyday experiences.

A subject on which very little accurate knowledge is available is the air consumption of rock drills, and in mines and minerals some interesting information has been made public in reference to the air consumption of the large number of rock drills in use at the Champion Mine. The drills are of Ingersoll-Sergeant make, number D-32, with a 3⅛-inch cylinder. The number of drills in use is about 75. The compressor plant consists of a Nordberg Quadruple Expansion Steam, two-stage air compressor. Four shafts are operated; the compressor is a thousand feet from the first shaft and 4,000 ft. from the last shaft. The main air line is 12 in. for the first thousand feet, and 10 in. for the remainder of the distance, while the lines down the shaft are 8 in., with branches at the levels. The compressor work was carefully logged, and about 230 to 250 cubic feet of free air are compressed for every pound of coal burnt under the boilers. In a table covering the results of a month's tests with 75 drills working, the average cubic feet free air per drill per minute was 67·10 for the day shift, and 58·09 for the night shift.

It is pointed out that the amount of air consumed per drill depends upon the number of drills in operation, a fact which is of course well established, for with a given air line the leakage is practically constant whether three or five drills are working. In moderate sized equipments the more drills in operation, the smaller the percentage of the drills working simultaneously. In tables given a single 3⅛ inch Rand drill required 120 cubic feet of free air compressed to 80 lb. at sea level. Five such drills consumed 500 cubic feet instead of 600 cubic feet as it would be if the air were used pro rata. Ten drills would consume only 884 cubic feet instead of 1,200 cubic feet.

Engineers are sometimes inclined to forget that, as Henry R. Towne recently said in an address at Purdue University, the dollar is the final term in almost every equation which arises in the practice of engineering. In other words the true function of the engineer is, or should be, not only to determine how physical problems may be solved, but also how they may be solved most economically. Therefore, the engineer is, by the nature of his vocation, an economist.

Industrial engineering may be limited strictly to the technical field; that is, may relate solely to the work of design. It is far more common however, for it to include, sooner or later, both technical and administrative work; that is, responsibility both for the design and character of the product, and for the economy of its production. Now, these two lines of responsibility may be separate. One man may be be responsible for design, and another for execution, and perfect harmony between them may produce a perfect result, but this is exceptional. The ideal condition is where the dual capacity existing, these two functions are united in one person. This combination is rare; it makes large opportunity and develops high value. It is rare partly because of average mental limitations, but much more because of one-sided training and opportunity.

A man may possess the technical skill which will enable him to design on paper every detail of an engineering scheme, but if he is ignorant in the direction of the complex system of labour, in the preparation and management of the intricate subdivisions of transportation, construction, excavation, mining, dredging, and finance, he will not answer the requirements of chief engineer. The organisation of men and the use of them to supreme advantage are important.

The industrial engineer should know every detail of his work. The criticism is sometimes made of a man that he is immersed too much in details, and unfortunately the criticism is often justified. If so justified, however, it is because the man, having a knowledge of the importance of detail, has not also a proper sense of proportion and an equal appreciation of the importance of letting go of detail at the right time. Grasp detail first; shed it afterward. Master every detail of the work you are responsible for until you understand how it should be done and why. Then shed that detail as fast as you can on your subordinates. Aim always that you shall know at least as much, if not more, about the work than any subordinate; that no one under you shall long or permanently know more that is important about it than you. Get as big men under you as you can, but try always to be bigger yourself, and if that implies fresh study and fresh work, do it.

Industrial management has become a vast field for the exercise of talents of the highest order, has developed wonderfully, and, in fact, constitutes a well defined science, although as yet it is almost without any text-books or other literature. This latter fact is regrettable, but no doubt will be remedied before long by incorporating into engineering courses in technical schools (as has been done already in several cases) instruction in the essential principles of industrial management, and its related art, industrial accounting. So long as present conditions exist, however, the necessity will continue for those men who turn to industrial management as a field for the exercise of their technical skill, to acquire the rudiments of that science through actual practice, precisely as in earlier days the rudiments of the technical work of the engineer could only be so acquired.

If the qualities required in a chief engineer were to be summed up in terms to be appreciated by those who are not engineers but still are keenly interested in the practical success of a large engineering proposition, it could be said that, estimating his total knowledge and experience as 100 per cent., about 25 per cent. should be classed as technical, 25 per cent. as executive, 25 per cent. as administrative and organising ability, and 25 per cent. as diplomacy and knowledge of human nature.

The awards in the motor-boat reliability trials have already been published, but there are portions of the judge's report which clearly call for comment. It is noted that although the design and equipment of the boats shows a marked advance upon last year, an important exception was found in the methods of fuel storage and supply in the petrol boats, which, except in one or two notable instances, left much to be desired. The chief defect noted in this respect was the connection between the tank and the carburettor, which in many cases consisted of a small pipe, indifferently fitted to the tank, and led unprotected, and in some cases right through the middle of the fore-peak, exposed and liable to damage. That this defect can be avoided was shown in some boats. Another matter for criticism was the inadequate silencing of the engines—in several instances a motor whose exhaust was sufficiently muffled was yet rendered noisy by clattering valves and tappets, or by an inefficiently silenced air intake. Electrical connections and fittings in some of the smaller boats also left much to be desired.

PAGE'S WEEKLY

An Illustrated Technical Weekly, dealing with the Engineering, Electrical, Mining, Iron and Steel, and Shipbuilding Industries.

DAVIDGE PAGE, Editor.

Clun House, Surrey Street, Strand, London, W.C.

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Alterations, &c., intended for insertion in the current week's issue must be delivered **not later than 4 p.m. on Monday.** If proofs are required the copy and blocks should reach us several days earlier.

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NEWS ITEMS.

The River Tyne Improvement Commissioners have decided, on the report of their engineer (Mr. James Walker) upon an elaborate scheme of rebuilding the coal shipping staith at Whitehill Point.

Messrs. Cammell, Laird and Co., Ltd., have been making extensions to their Grimesthorpe Steel Works at Sheffield. The chief feature of the extensions is the plant laid down for producing the highest class of tires for locomotives, carriages, and wagons.

The site which the State of Hamburg will offer to the Vulcan Shipbuilding Company of Stettin for the erection of new yards on the North Sea is situated near the Ellerholz Basin, which has the greatest depth of water of any dock in Hamburg and which would thus be eminently suited for the construction and launching vessels of the largest size.

It is reported that a Canadian Company, the Mexican Light and Power Company, has purchased all the electric light and power works in the City of Mexico. The purchase price exceeds $10,000,000, and it is anticipated that extensions and developments of the system will cost about $25,000,000.

The Midland Railway Company are building at their locomotive works at Derby ten new engines, from the designs of Mr. R. M. Deeley, the new locomotive superintendent. These, it is stated, will have a four wheeled leading bogie and four coupled wheels of 6 ft. 9½ in. in diameter, but the most striking improvement is in the boiler. Instead of 180 lb. of steam pressure carried by the 830 and 850 classes, the new engines have 200 lb. of steam.

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Submarine Signalling.

An official trial of the Millet system of submarine signalling, which has been adopted by the Cunard line and two of the great German companies, took place on Friday last under official auspices. In this system the tank, with an immersed microphone is the key to the whole situation, both for the reception of submarine sounds on board ship and for the transmission of them from a ship through the water to an observer outside. In fig. 1 the latest type of bell is illustrated whilst in fig, 2 the tank is shown in position. Repeated tests with bells in the open ocean have proved that a bell with a lip or sound bowl several inches thick and having a high musical note, although such a bell may be quite unsatisfactory in the air, gives the best carrying note in water.

In the experiments conducted on Friday last the Trinity House Yacht *Irene* was fitted with transmitters, which received the signals and passed them on to a telephone apparatus fixed in the chart room. The pneumatic signal bell was suspended 20 ft. under from the North Goodwin lightship. The trial appears to have been entirely successful, as at the test limit of three miles, the distance fixed for a vessel of small draught like the *Irene*, not only could the signals given by the bell be distinctly heard, but their direction easily ascertained, and indeed up to a distance of five miles the bell signals were very well received. Representatives of marine services in steamship companies were present during the tests, and this official recognition of this form of signalling appears likely to lead to the general adoption of the system, which, in the opinion of those best qualified to judge, is calculated to minimise the risk of accidents at sea. It is stated that the approaches to New York harbour and the Atlantic Canadian ports are already protected by the Millet system, the development of which is in the hands of the Submarine Signalling Company.

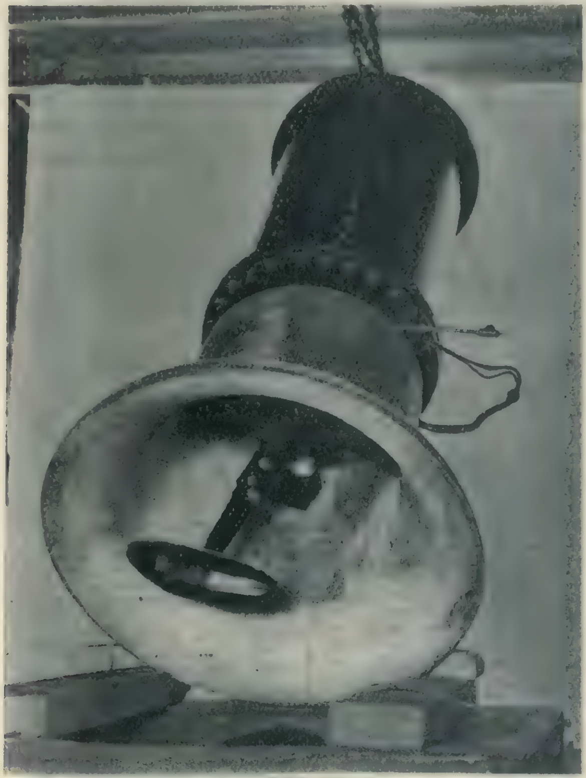


FIG. I. LATEST FORM OF BELL USED IN SUBMARINE SIGNALLING.

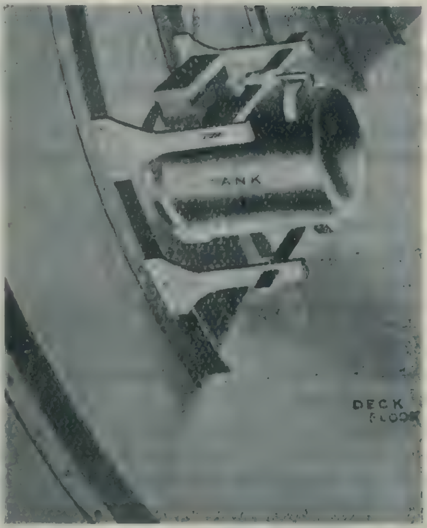


FIG 2. SHOWING TANK IN POSITION.

Electric Haulage on Canals.

The works in connection with the construction of the Teltow Canal are approaching completion. Already the power station which is to supply electrical energy for the working of the lock gates and incidental machinery, and also for the operation of the electric locomotives running on rails along the sides of the canal for the towing of boats, is nearly finished and equipped with boilers, and two 850-h.p. steam turbines and electrical generators, the latter of which are now yielding current for the experimental working of the lock. The track for the locomotives on the entire eastern section has been laid on both sides, while the rails and standards for the overhead wires have been partly placed in position on the western section. It is anticipated that only fifteen minutes will be occupied in the clearance of the single lock calculated from the time of arrival to that of departure, the average difference in the level between one section and the other being 10 ft. The haulage speed of the boats will be comparatively high in consequence of the practical absence of locks.

Royal School of Mines.

Mr. S. Herbert Cox has been appointed to the Professorship of Mining at the Royal School of Mines, South Kensington, vacant on the death of Sir Clement le Neve Foster. In view of the changes in organisation that may be found desirable in the Royal College of Science and the Royal School of Mines after the completion of the investigations now in progress by the departmental committee, it has been thought best to make this appointment a temporary one. Mr. Cox is an Associate of the Royal School of Mines. After experience as Assistant Geologist and Inspector of Mines in New Zealand, he was appointed Instructor in Geology, Mineralogy, and Mines in Sydney Technical College; concurrently with his tenure of this office he was employed to give technical lectures at various mining camps in New South Wales and practised as a mining engineer. Since 1890 he has been entirely engaged in private practice, and has had experience of mining in England, France, Spain, Egypt, the United States, and Canada. Mr. Cox was president of the Institution of Mining and Metallurgy in 1899–1900.

The Pedrail.

The Local Government Board have issued an order under the Locomotives on Highways Act, 1896, and the Highways and Locomotives (Amendment) Act, 1878, varying provisions as to the construction of wheels of locomotives on highways, so as to authorise, subject to conditions, the use on highways of locomotives having driving wheels shod with wooden blocks. In a circular accompanying the order the Secretary to the Local Government Board says that representations have been made to the Board to permit of a further variation of the provisions, so as to authorise the use on highways of locomotives the driving wheels of which are fitted with the contrivance usually known as the "Pedrail."

Electricity in Mines.

In connection with the new coalfield at Himley, near Dudley, which is being opened up by the Earl of Dudley, the whole of the plant will be up to date and the electrical equipment will be on an elaborate scale. All the subsidiary engines, motors, fans, and pumps will be electrically driven and electricity will be used, not only for lighting the surface but to some extent the interior of the mines, and will also be employed for haulage. A small temporary electrical plant consisting of a 130 h.p. high-speed engine direct-coupled to a three-phase alternator, is at present ready for use, and prior to the completion of the permanent station, will be employed for driving motors, fans, and pumps.

Gas for Power Purposes.

The Gas Committee of the Birmingham Town Council state that they have completed the purchase of coal for the current year on favourable terms; and in view of the saving effected, have reviewed the charges for gas supplied for use in gas engines. The attention of the committee has also been directed to the development and perfecting of appliances for the manufacture of producer gas, which can, under favourable conditions, be substituted for coal gas for motive power purposes. After fully considering the position, the committee recommend that all gas for use in gas engines, irrespective of quantity, shall, as from the next quarterly reading of the meters, be supplied at the lowest current rate of 1s. 10d. per 1,000 cubic feet, with discount of 5 per cent. on the usual terms, or slightly under 1s. 9d. per 1,000 cubic feet net. Gas used for gas engines will, as hitherto, be registered by separate meters.

New York Municipal Lighting Station.

Plans have been approved for the erection and equipment of a municipal lighting station in New York at a cost of £1,500,000. This outlay is estimated to give the city 15,000 public arc lamps at an annual cost of £13 each and 300,000 incandescent lamps, mostly for the official buildings, at a cost of 2¾d. a kilowatt hour, as compared with £29 and 5d. paid at present to the New York Edison Company and its allied corporations. The Electric Lighting Commission estimates that operating expenses will amount to £253,400 a year, including all fixed charges, and interest on loans at 3½ per cent. Meanwhile, the New York Edison Company has placed an order for three new turbo-generators each of 16,000 h.p. capacity, and is planning ultimately to have ten of these large sets at its Waterside station on 39th Street, Manhattan. The new turbines are to be supplied by the Westinghouse Company, Pittsburg.

Grand Trunk Pacific.

The building of the Grand Trunk Pacific Railway will be the most important engineering work undertaken in the Dominion for many years. The line will extend across Canada wholly upon Canadian soil from Moncton, New Brunswick, in the east, to a point near Port Simpson, in British Columbia, on the Pacific Coast. The total estimated length is 3,500 miles. It will be standard gauge, and divided into two main divisions, known as the Eastern (Government) Division and the Western (Grand Trunk Pacific Company) Division. As regards the general route, the Eastern, or Government Division is from Moncton, westward through the central portion of the Province of New Brunswick, and thence through the Province of Quebec by the shortest available route to the city of Quebec. It will continue westward through the northern portions of the provinces of Quebec and Ontario (New Ontario), and through Eastern Manitoba to Winnipeg. The estimated length of this division is 1,800 miles.

Prairie and Mountain Section.

The Western, or Company's, Division, with an estimated length of 1,700 miles, is divided into two sections, the Prairie section and the Mountain section. The former will begin at Winnipeg, and proceed north-west through Western Manitoba to the Rocky Mountains, the Mountain section being through the mountains to the coast. Provision is also made for branch lines. Among the first of the works to be undertaken by the company will be the building of the 220-mile branch line from Fort William west and north to a junction with the main line at a point 230 miles east of Winnipeg, to give direct connection between Winnipeg and Lake Superior. This is of great importance. Other branches will eventually be built north from Montreal and from North Bay to form connections with the main line. The company has power to build branches from the main line—Prairie section—to Brandon, Manitoba, and to Regina, Prince Albert, and Calgary respectively, in the Territories. It also has a charter to run a line north near the coast to Dawson city.

Electrical Exhibition.

An important electrical exhibition will be held at Olympia from September 25th to October 21st next, and as it is a good many years since an exhibition of such magnitude was held in connection with the electrical industry, it ought to prove a great success. No industry has made such strides during recent years as that devoted to the application of electricity to industrial purposes, and this will afford an admirable opportunity to measure the advances made in electrical science. The exhibition will be held under the auspices of the National Electrical Manufacturers' Association. Sir William H. Preece has been elected chairman.

Position of Shellac.

The very strong position of this article has again been emphasised by the steady and important withdrawals from warehouse, which have latterly exceeded arrivals by as much as 3,500 cases. The excess of the home deliveries over imports for the last seven months is no less than 20,691 cases. This naturally accounts for the heavy shrinkage in the London stocks, which at the end of July aggregated only some 22,000 cases. The outgoings since the beginning of the month have continued satisfactory, while the assortment of the best marks has become limited, and holders of such are not easy to deal with. The outlook is for still higher prices. A fairly active business has lately been booked for distant delivery, and the repurchases likely to be effected to cover contracts during the next few weeks may accelerate a further advance, although occasional manipulation in Calcutta may be reflected in this market.

Ottoman Empire.

A vice-consular report from Haifa states that the construction of the Haifa-Damascus Railway is proceeding on the other side of the Jordan River, and it is probable that the line will reach Damascus towards the end of this year. When the railway is completed to Damascus there will be openings for oil engines for working flour mills and for irrigation purposes, as water is scarce in that district. Agricultural machinery will also undoubtedly find a good market.

Photo, Elliott & Fry.

THE LATE SIR WILLIAM LAIRD CLOWES (*see page* 347).

NAVAL NOTES.

THE five sea-going destroyers included in the naval programme present one or two features of interest, and the builders are under very stringent conditions with regard to speed. The new boats will show a decided advance in this respect, the speed guaranteed being 33 knots with the vessels carrying a load of coal sufficient to give a radius of action of 3,000 miles at ten knots. A condition of this character, coupled as it is with stipulations for heavier scantlings, is calculated to cause a healthy rivalry between the five firms who have each been allotted the contract for one of these destroyers. The boilers are to be of the Express type, to be adaptable to the use of oil fuel, and Parsons turbine sets will be fitted with cruising turbines. In view of the speed demanded it will be interesting to see what the Admiralty intend to do with regard to the establishment of a deep water trial made off the Goodwins as suggested at the recent meeting of the Institution of Naval Architects. The difficulties attending the use of the Maplin mile for high speed trials has been amply demonstrated.

The old and vexed question of longitudinal bulkheads in warships has been raised again, and there is a tendency to discuss it as if some really novel point had been suggested. The old argument as to the danger of the longitudinal bulkhead in confining the water to one side of the ship is hashed up again, and the tendency to turn turtle is backed up with facts collated from the great naval battle of the Japan Sea. It appears to be forgotten that ship designers have only retained the longitudinal bulkhead because it formed part of the necessary compromise which the design of a warship implies. A suggestion has been made that by the employment of the 'long-arm' system of power doors the difficulty can be solved. Some naval architects are in favour of additional transverse bulkheads, the wing bulkhead at the same time being strengthened and the power doors employed for bunker and passage openings.

The American battleship *Kansas*, the largest warship built at an Eastern port, was launched at Camden (New Jersey) on Saturday last.

The first term of the new Naval College at Dartmouth will begin on September 15th, when the cadets from Osborne College will join the establishment. The college was practically opened on Tuesday last when the officers of the *Britannia* transferred their quarters to it. The new ward room is at the western end of the college buildings.

The naval section of the Imperial Russian Technical Society has just completed an investigation as to the possibilities of constructing a new Russian fleet in Russian shipbuilding yards and has arrived at the conclusion that this can be done. In five years' time, it is stated, the Baltic Works can build eight first-class cruisers, and the Galerny Island and New Admiralty yards 12 first-class battleships. Kronstadt, with its Peter Dock, is in a position to construct armoured cruisers of the improved Bayan type and sea-going gunboats or torpedo transports. Torpedo cruisers and submersibles may be ordered of the Neva works and of Lange's works in Riga. Sea-going torpedo-boats (including destroyers) and coast defence torpedo-boats can be successfully built in the small shipbuilding yards of Finland, Riga, Revel, and Libau, which may also take in hand the construction of part of the torpedo transports of storeships required.

The Putiley Works can complete in the same period four cruisers of the Bayan type and a number of torpedo-boats and gunboats. As to the works in the south of Russia, it is estimated that Nikolaieff and Sevastopol can complete four battleships, four cruisers of the Bayan type, and some torpedo-boats. In regard to machinery, orders may be placed, besides the Baltic Works, with the Franco-Russian, Sormovo, Briansk, St. Petersburg Metal Works, Nikolaieff Works, and those of Nobel and Lessner (both in St. Petersburg). Orders for auxiliary mechanisms may be distributed among the numerous other smaller works.

As to guns and torpedo gear, although precise data are not forthcoming on the capacity of the Government works for their production, the Society is of opinion that their output might be increased to the desired degree. Private works can supply a large quantity of torpedoes and projectiles. The manufacture of armour-plating presents the greatest difficulty, and in all probability part of the orders will have to be placed abroad, although this branch of industry is capable of considerable expansion, if only the money can be found for the plant.

Points to be noted in the policy which has been outlined as to the constitution of a future fleet are the very small number of cruisers and the evident belief in the fighting power of the submarine, in the development of which it need hardly be said, Russian engineers have played a not unimportant part. As to battleships, it is an obvious necessity that a certain number should be built, and it is calculated Russian yards could in ten years build twenty-nine. The policy thus sketched out makes provision for a large fleet of gunboats, and this could only mean that the need of the Far East is still to be a potent factor in Russian naval administration.

LEEDS ASSOCIATION OF ENGINEERS.

The members of the Leeds Association of Engineers, conducted by their president, Mr. W. H. Drake, and secretary, Mr. Robert Lupton, visited Sheffield on August 9th, and inspected the steel works of Messrs Edgar Allen and Co., Ltd. They were received by Mr. R. Woodward, the vice-chairman, and Mr. F. A. Warlow, managing director, and were shown round by members of the staff.

The most interesting feature was the improved application of the penumatic method of steel melting invented by M. Tropenas, of Paris, the blast of air not being introduced at the bottom of the converter, as in the original invention associated with the names of Sir Henry Bessemer and Mr. R. F. Mushet, but at the side. There are two rows of tuyeres, the bottom row acting upon the molten metal only, and the top row on the gas evolved. Working at a pressure of blast up to 4 lb., the most intense heat is generated, and the metal also less disturbed than in other converters. Such was the fluidity of the steel that it was carried long distances and run into moulds without stiffening. The time occupied for each blow was about twenty minutes, the castings ranging up to twelve tons each. The Tropenas installation comprises three 3-ton and two 25-cwt. converters, and is capable of turning out over 300 tons per week. The Government have also arranged for its use at the Royal Arsenal, and similar installations are now working on the Continent and in the United States.

An enormous quantity of points and crossings for tramways were being made from manganese steel, so tough as to be practically unbreakable. These were being fitted to rails from the Leeds Steel Works for supply to the principal English municipalities, including London, Manchester, Birmingham, Leeds, Nottingham, Newastle, etc., and for the Continent and South Africa, for which latter thousands of railway wheels and buffers were being made.

The visitors were also shown the process of manufacture of all kinds of cutting tools from air-hardening crucible steel from diamond stone-cutting saws, 7 ft. 4 in. in diameter downwards. Such tools are supplied to the United States and all parts of the world. It was not a little pleasing to see the rate of turning and drilling employed in the machine shop, iron castings being turned at a speed of 120 ft. a minute with a $\frac{3}{4}$-in. cut; a ·60 carbon steel shaft with a similar cut at 60 ft. a minute and drilling done at 6 in. a minute.

Electrical power was being adopted where practicable for driving overhead cranes and other appliances.

OBITUARY.

Sir William Laird Clowes.

The death of Sir William Laird Clowes, which took place on Monay last, removes one of our leading naval experts. He was the eldest son of a Registrar in Chancery, and was born in 1856. Educated at Aldenham, and King's College, London, he afterwards proceeded to Lincoln's Inn, but decided to abandon the Bar in favour of journalism, which vocation he followed in the provinces and subsequently in London. Although writing a great deal on miscellaneous topics, the greater part of Sir William's energies were devoted to the study of the Navy. In 1882 he began to specialise on naval affairs, and for a number of years he acted as naval correspondent for several prominent London newspapers. This work led to the projection by himself and others of a new naval history, and it was then that he began to collect original manuscripts and books relating to the object he had in view. It is, perhaps, as the editor of the work which was the outcome of these ideas, "The Royal Navy, a history from earliest times to the death of Queen Victoria," in seven volumes, that he is best known; and it was in recognition of the excellent work put into these volumes that in 1892 he received the honour of knighthood. It is generally admitted that his "Needs of the Navy" was chiefly responsible for the remarkable increase in the Navy estimates for 1894, when, as will be remembered, they leaped at a bound to upwards of £3,000,000 more than they had ever before been in times of peace. Sir William was a gold medallist of the U.S. Naval Institute, and an honorary member of the Royal United Service Institution. An article from his facile pen, dealing with the relative importance of offensive and defensive qualities in men-of-war, appeared in our issue of May, 1903.

Mr. William Langdon.

The late Mr. William Edward Langdon was formerly telegraph superintendent and chief of the electrical department of the Midland Railway. His professional career began with the Electric and International Telegraph Company, and at one time he was assistant to Mr. (afterwards Sir) W. H. Preece. On the transfer of the telegraphs to the State, Mr. Langdon was appointed head of the telegraph department of the London and South-Western Railway Company, afterwards joining the Post Office staff in the capacity of assistant divisional engineer. He relinquished this position in 1878 to take charge of the Midland Railway Company's electrical department, and spent twenty-five years at Derby in that service. He was a member of the Institution of Electrical Engineers, and at a period of emergency in 1877, he acted as secretary. He served on the Council of the institution since 1895 and during 1901–2 he was the occupant of the presidential chair.

Mr. David Evans.

A prominent member of the metallurgical industries of the North of England has passed away in the person of Mr. David Evans. Born at Aberdare in 1841 he received his early training under his father, who was the manager of the Aberdare Ironworks, and, in 1866, he succeeded him. In 1891 the directors of Bolckow, Vaughan and Co., offered Mr. Evans the general managership of their works, which he accepted, and for thirteen years he occupied that post, until ill-health compelled him to relinquish the position last October. In addition to his duties as manager of this firm the late Mr. Evans was also associated with several other public and private concerns. He was a member of the Tees Port Sanitary Authority, a member of the Tees Conservancy Commission, a past-president of the Cleveland Ironmasters' Association, a member of the Council of the Iron and Steel Institute, a member of the Institution of Civil Engineers and of the Institution of Mechanical Engineers, a member of the Council of the British Iron Trade Association, a vice-president of the Cleveland Institution of Engineers, a member of the American Institute of Civil Engineers, a member of the Institution of Naval Architects, and the representative of the British Steelmakers' on the Committee of Lloyd's Register of Shipping.

Mr. Thos. Finlayson.

The death is announced of Mr. Thos. Finlayson, a well-known civil engineer, in his eighty-sixth year. His early experience was gained in the office of Messrs. Ross and Mitchell, and in 1859 he went out to India as civil engineer in connection with the Madras Railway, then in process of construction (Madras to Bombay and Bangalore). He received the thanks of the Home Government, on the recommendation of Sir Charles Trevelyan, for his services in securing the salvage of a Government vessel with military stores which had stranded on the bar. Mr. Finlayson resigned his position in 1862 and came home. His most notable work in later years being done in connection with the Central Argentine Railway, for which he secured the concession.

THORNYCROFT 14-H.P. CAR.

1906 DESIGN.

THIS new car, illustrated in drawing on opposite page, is, with the important exception of the engine and a few other details, similar in design to the 20 h.p. Thornycroft car.

The engine is of the four-cylinder type, the bore and stroke of which are each 3¾ in. The valves, mechanically operated, are inverted, and open direct into the top of the combustion chamber, each valve being controlled by means of a separate rocking lever. These levers are actuated by means of tappet rods worked directly from the cams, the cam shaft being enclosed in a casing bolted to the cylinders at the top and side. By taking off the end cover of this casing the whole cam shaft, together with its bearings, can be pulled out and inspected.

Lubrication is forced to the whole of the moving parts by means of a gear-driven pump in the base of the crank chamber, the claw-coupling drive of which allows the bottom cover of the crank chamber to be removed without disturbing any of the gearing. The water-circulating pump and magneto machine, fitted on either side of the vertical spindle, are driven from it by means of a bevel wheel, the gearing being enclosed within the crank case, while the couplings for pump and magneto are immediately outside the casing and can therefore be easily disconnected. The governing is of the spring-loaded cross-linked type; it is connected to the throttle valve, which is hand controlled, and it can be set to govern at any speed.

The crank-shaft, which is cut out of a solid billet of best mild steel, has five bearings, the flywheel being secured to a flange on the shaft by means of bolts; and the pistons are of cast iron, with four cast-iron spring rings, the connecting rod being of stamped steel.

Low-tension ignition is fitted, with "make and break" in the cylinder. The rocking levers actuating the ignition gear can readily be inspected by removing the side covers of the cam casings carrying the "make-and-break" gear. High-tension ignition, by means of accumulators and coils, can be fitted in place of, or in addition to, the magneto "make-and-break" gear, if desired; provision is made at the back end of the cam casing to permit of a high-tension distributor being fitted and driven from the cam shaft by means of a pair of bevel wheels. The carburettor is of the float-feed type, having a spring regulated automatic air control; it is fixed in an accessible position, being bolted to one of the supporting arms of the crank case. The "friction-disc" principle is employed on the clutch, similar to that fitted on the 20 and 24 h.p. cars, and it is claimed to give great elasticity, "taking up" without the slightest jar or jump.

SPECIAL FEATURES OF THE DESIGN.

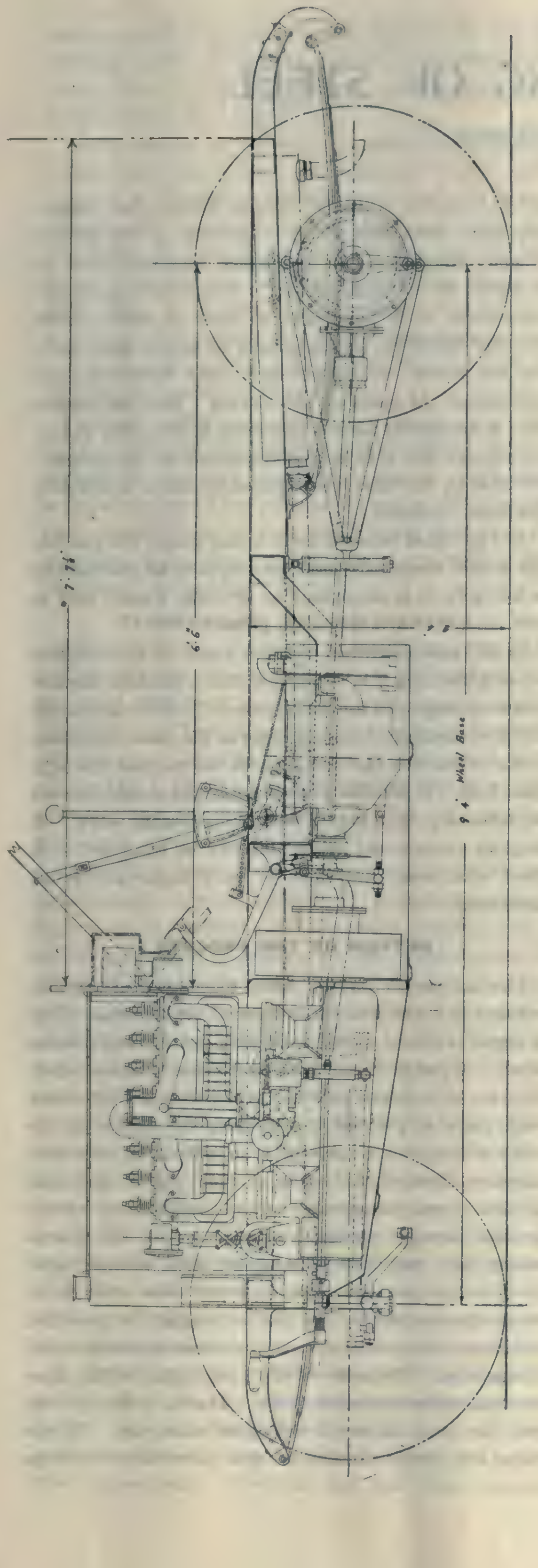
The gear box is of aluminium, and is provided with a large flat top cover to facilitate examination immediately under the footboards. In the design special attention has been given to reducing the lengths of the gear-wheel shafts and thus to prevent the "springing," which is such a fruitful source of trouble where long shafts are employed. Three speeds forward and a reverse are provided for, the drive on the top speed been direct, no gear wheels being employed for the transmission of power.

The back axle, to which the drive is transmitted by means of a cardon shaft, is of a special design, the differential being of the spur type, while the main drive is by means of a bevel wheel and pinion. It is wholly encased, and runs in oil. The tendency of the axle casing to run round the axle is taken up by a triangle, of which the axle casing forms the base. The apex of this triangle is a ball, which fits in a circular casing containing two stiff coil springs of a square section. The spring casing is fixed to the frame cross member in which the underframe terminates. By this arrangement all shocks arising from starting, stopping, reversing and braking are carried by the direct triangle and taken up by the coil springs.

Lubrication is, as noted previously, forced to all moving parts of the engine, while the remainder of the bearings, friction disc clutch, gear box, axle, etc. are encased and run in heavy oil.

Two brakes are fitted, a hand-brake operating on V-shaped brake drums on both driving wheels, and a foot-brake acting on the cardon shaft immediately outside the gear box.

The starting handle is so arranged that, after starting, it remains in a vertical position above the crank shaft, this device preventing the handle from being splashed with mud.



SIDE ELEVATION THORNYCROFT 14 H.P. CAR. 1906 DESIGN.

THE DARTFORD IRONWORKS.

(J. AND E. HALL, LTD.).

WE illustrate on page 338 the machine shop and turnery of the Dartford Ironworks, the origin of which dates back to 1785.

The works first began their connection with refrigeration, which is now their sole interest, in 1878, when they brought over the Giffard cold air machine which had been exhibited at the Paris International Exhibition of 1877; and in the early eighties the firm were at work fitting ships, both for the carriage of frozen meat and for maintaining passengers' provisions.

In 1888, the firm brought out the CO_2 refrigerating machine with which their name has been so closely identified, and this machine has, it is stated, since been largely adopted in the mercantile marine.

The impetus thus given to the business, coupled with the large demand for machines for all kinds of land purposes where refrigeration is required, has necessitated the laying down of extensive new plant and considerable enlargement of the works. The company now devote themselves entirely to this class of work to the exclusion of all other forms of engineering.

The Dartford shops were amongst the first in this country to adopt the electric welding process, which they have now used for many years for the manufacture of coils required for refrigerating machines, the amount of 1½-in. pipe welded up per day often amounting to 4,000 ft. run.

The works include iron and brass foundries, pattern and carpenters' shops, machine shop, brass finishers' shop, coppersmiths' shop, smithy, coil-making and casing shop, and erecting shop, the latter being specially laid out to enable machines to be run after completion, when each one is tested and the amount of refrigerating work which it will do accurately measured.

Amongst the special tools is one designed for machining the steel compressors of the refrigerating machines which are bored from solid forgings of high carbon steel.

The works are driven throughout, as well as lighted by electricity generated in their own power house by two Willan and Robinson's engines, direct coupled to E. C. dynamos of 220 kilowatts. In the same power house are situated an air compressor which gives the power for working pneumatic tools, some very high-pressure air compressors used for testing all parts of CO_2 machines subject to the pressure of that gas; also the electric welding dynamos and various pumps for working hydraulic tools and testing.

CASE HARDENING OF STEEL.

By David Flather.

The process of case hardening consists in bringing the steel or iron articles into contact with carbon in closed boxes or pots and raising them to the requisite temperature for a sufficient length of time; afterward the articles are reheated and cooled by quenching in oil or water. The furnace should be so constructed as to be capable of being raised to a full orange heat (1,000 deg. C.), and maintained at that heat with great regularity. Neither the fuel nor the direct flame should come into contact with the charge—which is to say that the flames should uniformly impinge on the sides and roof of the muffle, thus heating the contents of the muffle by radiated and not by direct heat. The result is most economical in the matter of fuel. There should be a small peep hole in the door, with a cover plate; a hole 1½ in. in diameter is quite large enough.

Fig. 1 shows a small furnace of type employed There is an upper chamber in this furnace, and though this is not necessary for case hardening it may in a small works be found useful to have such a chamber and employ it, while case hardening is being done, for the insertion of any articles which require annealing. This will add only very slightly to the amount of fuel used. Generally speaking, coal is the fuel employed; but for large works, where a number of furnaces are kept going, gas-fired furnaces should give every satisfaction. Hardening pots are made in both cast and wrought iron. The latter bear reheating so many times that they are cheaper in the end. The pots should not be of too large dimensions, or there is great risk of articles in the middle of a charge not being cased to a sufficient depth. The pots should each have a plate lid fitting closely inside.

Perhaps in no part of the process have there been so many differences of method as in the question of the carbonising material. The carbonisers in general use at the present day are animal charcoal, bones, and one or two other compositions sold under various names, and consisting of mixtures of carbonaceous matter and certain cyanides or nitrates. For very slight hardening cyanides alone are still found very useful, but no great depth of casing is ever attempted with these.

Theoretically, the perfect carboniser should be a simple and pure form of carbon. The writer has found good charred leather to give the most certain and satisfactory results. Charred leather should be bought only from some firm which is actually in the leather or some allied business, and which uses this trade as an outlet for its scrap leather. Even under such circumstances it is important to keep a strict watch over the deliveries, and especially to keep a good lookout for traces of copper and steel rivets—a sure evidence of old boots or old belting. Buy the leather coke in lumps and have it powdered in your own works, taking care that it is not contaminated in the process, and that by the time it is required for use it is perfectly free from moisture.

As clay must be used for a luting round the pot lid, and is also frequently used for stopping off portions to be left soft, it is important to see that a good clay is used, and that it is free from grease.

As all case-hardened articles have to be reheated before quenching it is important that a suitable furnace should be employed for the purpose. It is not advisable that the reheating should be done in the case-hardening muffle, unless it is run specially for the purpose and at a lower heat. If possible a small gas muffle should be used for reheating, and indeed for all hardening work. A properly constructed gas muffle can be regulated with great exactness, and this is very important in all hardening.

DETAILS OF THE PROCESS.

The carboniser having been thoroughly dried and reduced to a fine powder, a layer of not less than 1½ in. in depth is placed in the hardening pot and well pressed down. Upon this are placed the articles to be hardened. Care must be taken to leave sufficient space all round each piece to prevent its touching the others or the walls of the pot; a space of 1½ in. should be sufficient. Another layer of carboniser is then put in and well pressed down, taking care not to displace any of the articles already packed, continuing until the pot is nearly full, and then finishing off with another layer of 1½ in. at the top. The object in view must be to make the contents of the pot as compact as possible, consistent with a sufficiency of carboniser in contact with the articles. The more solidly a pot is packed the more effectual is the exclusion of air. The lid is then put on and the joint all round well luted with clay. By the time the proper number of pots have been filled the furnace must have been raised steadily to the full working heat. According to my experience, the proper heat for case hardening is 1,000 degrees C., or a full orange "heat colour."

At the close of the carbonising period the pot is withdrawn from the furnace and placed in a dry place, where it is allowed to become quite cold. It is then opened and the articles taken out and brushed over to remove all adhering matter. If the pot has been properly packed and luted up the articles should be quite white, or, at least, have only a slight film or bloom of a deep blue colour; the denser and more inclined to redness is the surface the more imperfect has been the packing and sealing of the pot.

The case hardened articles are now placed in a muffle furnace, and steadily raised to a good cheery red (800 degrees C.), and then quenched in cold or tepid water or oil, according to the purpose of the article required. They should remain in the cooling liquid until they are quite cold right through the body of the metal, thus completing the process.

TEMPERATURE OF CEMENTATION.

Then we have to determine at what temperature we are to work the cementation part of the process, and to decide this there are several points to be strictly observed. (1) The carbon in the case must be about 0·80 per cent. (2) The case must be neither too thick nor too thin. (3) The temperature must not be so high as to overheat the mild centre. (4) The core must be of the greatest possible strength.

Although I have given separate requirements, we must consider them altogether. A temperature of 1000 degrees C., if continued to saturation, would yield a carbon percentage of about 2·5; but if interrupted at any stage short of saturation the skin would contain less carbon, and the centre still less, on account of the process of diffusion being still in progress. If we take two pieces of $\frac{5}{8}$ in. diameter round mild steel, and heat one of them with a carboniser at a cherry red heat, and the other at a bright orange heat for six hours, the first will be cased to a depth of about $\frac{1}{32}$ in. and the other to a depth of nearly $\frac{1}{16}$ in., while the amount of carbon taken up will be about 0·50 and 0·80 per cent., respectively. So that, so far as regards the hardness of the skin, the piece cased at the higher temperature gives the best result. From this we learn that a temperature of 1,000 degrees C. will give us sufficient hardness of case.

We have next to find which temperature has the least hurtful effect on the mild steel core. Suppose, for example, we take three pieces, heating at 1,000, 1,300, and 1,500 degrees C., or full orange, white and bright white respectively. We shall find that those at 1,300 and 1,500 degrees break very short and have lost nearly all their original tenacity; while that at 1,000 degrees appears tougher and altogether stronger than before.

WATER HARDENING.

That part of the process where a more important improvement has been made is the final hardening by quenching in water. In case hardening, as in all other methods of hardening, the steel must be quenched on a rising heat. I may add, that for certain purposes there is some advantage to be gained by quenching direct from the pot, if followed by reheating to cherry redness and again quenching. Having made clear the necessity for complete cooling after carbonising, followed by reheating for water hardening, we may proceed to consider the proper manner of carrying this out. We must remember that the case hardened article now consists of two kinds of steel, one being mild steel of a temper that will not harden in water, and the other capable of becoming glass hard when properly heated and quenched. The critical points of the two steels are not of course the same, that of the hard steel being slightly lower than that of the soft steel. It must be borne in mind that to obtain complete hardness in the skin, and the maximum of strength in the core, they must both be heated to their critical temperature before quenching. Now, as the critical points of the two are not identical, and as they must be raised at

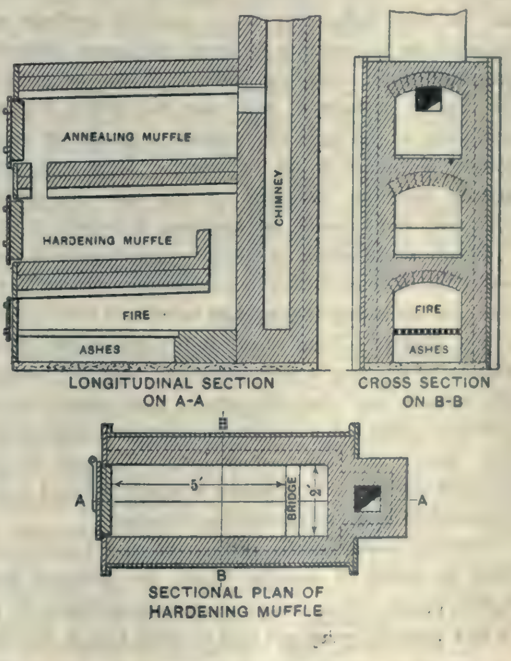


Fig. 1.—Small Annealing Furnace for Case Hardening.

least up to these points, it follows that one of the steels will have to be heated considerably above its proper hardening point, or the other not heated sufficiently, to reach its greatest tenacity. We have therefore to find which of the two will result in the least risk. If we heat the article to the critical point of the hard steel case we do not reach the critical point of the mild core; and, on the other hand, if we raise to the proper heat for the mild we exceed that of the hard steel.

TO OBTAIN MAXIMUM STRENGTH.

As our object is to obtain hardness combined with strength, and as the strength lies almost entirely in the core, it follows that we must heat sufficiently to remove the coarse crystallisation of the core, thus exceeding the critical point of the case; and, in doing so, while we obtain very nearly the maximum hardness, we lose very little of the strength of the case, and obtain the maximum strength of the core. I have gone rather fully into this point, and, it may be thought, without necessity, as the temperature is almost universally judged by the eye. But my object in doing so is to point out how important it is for the second heating to be sufficiently high to obtain the best result. The case hardened steel as it comes from the pot cannot be rendered hard and strong without a sufficient second heating. If a test piece or finished article when broken shows a more or less coarsely granular fracture and has the casing irregularly defined it is an almost certain evidence that the second heating has not been sufficiently high; and this perhaps emphasises the importance of using test pieces wherever possible. This reheating should, so far as possible be rapidly performed, and once the article becomes uniformly of the right temperature it should be immediately quenched in oil or water. It is sometimes desired that the hardness of the case be slightly tempered, but I cannot say anything in favour of it.

It may be desirable for special requirements to make extreme hardness the first consideration. In such cases the case hardening heat may be raised to a bright yellow (1,250 degrees C.), and then, at the end of the period, instead of allowing it to become cold, take the pot from the furnace, and when the articles have cooled to a full red heat, quench in water or oil, afterwards reheating to full cherry and again quenching. Though by this method the absolute strength is much reduced a considerable increase of hardness is obtained.

Having discussed the process of case hardening it may be useful to consider briefly the principal faults which occur. It is always of great importance to put a test piece in every pot and to treat this in the same manner exactly as the articles being hardened. It is, of course, most useful to take one of the articles themselves and use it as a test piece, and where possible this should be done. The tests to be applied come under the heads of "hardness" and "strength." The hardness in the absence of any special scientific tests, is proved by the use of the file; for this purpose a smooth saw file should be employed, and this is a test too well known to need any repetition here. I may, however, remark that when using the file, and it appears as if the test piece were not fully hard, before deciding that this is really the fact it is well to examine the file used. It may then be found that what were thought to be filings from the test piece are really the powdered teeth which have been forced away from the file. Sometimes the extreme surface is quite easily touched by the file and the articles are declared to be soft; if, however, the filing is continued a dead hard surface is found beneath. This has been caused by the action of the air on the steel, either by incomplete sealing in the pot, or more probably by want of care in reheating.

We have next to consider the fractures of the test pieces, and I may repeat that the structure of steel, as shown either in the fracture or the polished and etched section, contains a certain record of at least the last heat treatment through which it passed:—

(*a*) Perfectly case hardened steel when fractured will show a case of extremely fine white grain, which is clearly defined and of very regular depth, while the core is finely granular and of a distinctly metallic lustre.

(*b*) The case, instead of having a fine, white, dry appearance, is full of minute, brilliant specks, and is not so clearly defined. The core is much coarser and more sparkling, and the test piece would break easily, being more or less rotten. Such a fracture shows either that the article was quenched direct from the pot, or that, if heated a second time, it was not raised to a temperature sufficiently high to rearrange the structure caused by the high temperature of case hardening.

(*c*) The outer zones of the case are coarser, as in (*b*), while the remainder, and also the core, are very little coarser than (*a*). This is the result of too high a temperature in reheating. An article having such a structure would, though full of hardness, wear into little pinholes and specks, and in certain articles of small dimensions very easily break.

(*d*) The case appears as in (*b*), but the core is grey and fibrous, or when broken laterally shows very marked laminations. This is caused by too high and too long heating before quenching.

Abstract of a paper read before the Cycle Engineers' Institute.

IRON ORE DEPOSITS ABROAD.

POSSIBLE FIELDS FOR FUTURE ENTERPRISE.

(*Continued from page* 298)

NORWAY.

THE uniform character and compactness of the ore, and the position of its various exposures, give grounds for a favourable opinion of the value of the Sordalen claims, and the amount of good ore available in this district may be safely estimated, if only worked to a depth of 60 metres, at over 1,000,000 tons.

In the case of the Georlanger group of mining claims, while there is not sufficient data to justify an estimate of the amount of ore here available, the position of the outcrop is so favourable and the facilities for shipment are so great that mining operations may be commenced with confidence in a successful result, and should the working prove that there is a large development of ore at this place, its advantageous position for both working and shipment must ensure important financial results.

The extensive district through which the Loland group of claims is spread has a length of about 12 kilometres from the shore of the lake called Espelands Vand, at Loland, on the west, to the precipitous highlands overlooking the great Sogne Fjord at Raa, on the east.

Should the beds of ore prove to be continuous throughout the district, the amount of available ore must be over 20,000,000 tons. The position of the ore is in every case above sea level, and above the level of the surface of adjacent lakes, so that the mining would be by open workings to a large extent.

In the Christiana district there are deposits, not of great importance, however, which the owners, often poor people, would probably sell on reasonable terms. The difficulty is the scattered nature of the mines and want of capital in Norway. It is thought, however, that if many concessions were gatherd in one hand there might be a chance of working at a profit.

KRAGERO.

The Dobbe deposits are rather over 1,000 yards from the sea, where ore could be loaded, and the Grönaasen and Sjaaen deposits about 300 and 450 yards respectively, and all more than 100 metres above sea level. For this reason there would be no need to transport the ore to Kragerö for loading. An aerial railroad could bring the ore from all the deposits down to the ship. The owners would be sellers on reasonable terms. Mr. Vice-Consul Gray, writing on the general question, points out that while no insurmountable obstacles to mining in Norway appear to exist, he has to draw attention to the formalities of Norwegian law which render the acquisition of mining rights by foreigners dependent on the consent of the King; and, further, to a recent proposal now dropped for the time being, to place what practically amounts to an export duty on ore, in the form of altering the clause of the Customs tariff, under which partial exemption from tonnage and light dues is at present accorded to vessels exporting ore from this country.

Herr A. Backe, superintendent of mines in the district of Tromsö, states that a number of iron deposits occur in this district, many of which will be of importance when the demand for iron increases and technical knowledge develops, as most of them are favourably situated at comparatively short distances from the sea; only short railways or aerial tramways are necessary, so that cost of transport will not have to be taken into account in calculating cost of production. With the exception of the Dunderland, Naverhangen, Bergvik, and part of the South Varanger deposits, too little labour has as yet been expended to be able to determine the amounts of ore than can be reckoned upon from each field, as capital has been wanting. It is therefore, as yet, impossible to form any estimate as to costs of working; they would, however, probably be about the same as in the case of the Dunderland deposits, with, however, the differences which may be entailed by their position and the weaker strength of the ores. The Dunderland deposits have become to a certain extent the property of the English Company of that name, and all owners would, it is stated, be glad to sell.

SWEDEN.

The largest known individual deposits in Scandinavia, with not many equals in size in Europe or America, are in the Stockholm district, but as the chief deposits are in strong hands it seems improbable that the owners would be disposed to sell. There might be much difficulty in obtaining a good title to iron ore in fields in Sweden—foreign capital, apparently, being little desired in this country, except under native management—yet, on the other hand, there is nothing to prevent the output of ore from Swedish mines being for due consideration almost indefinitely increased.

(*To be continued.*)

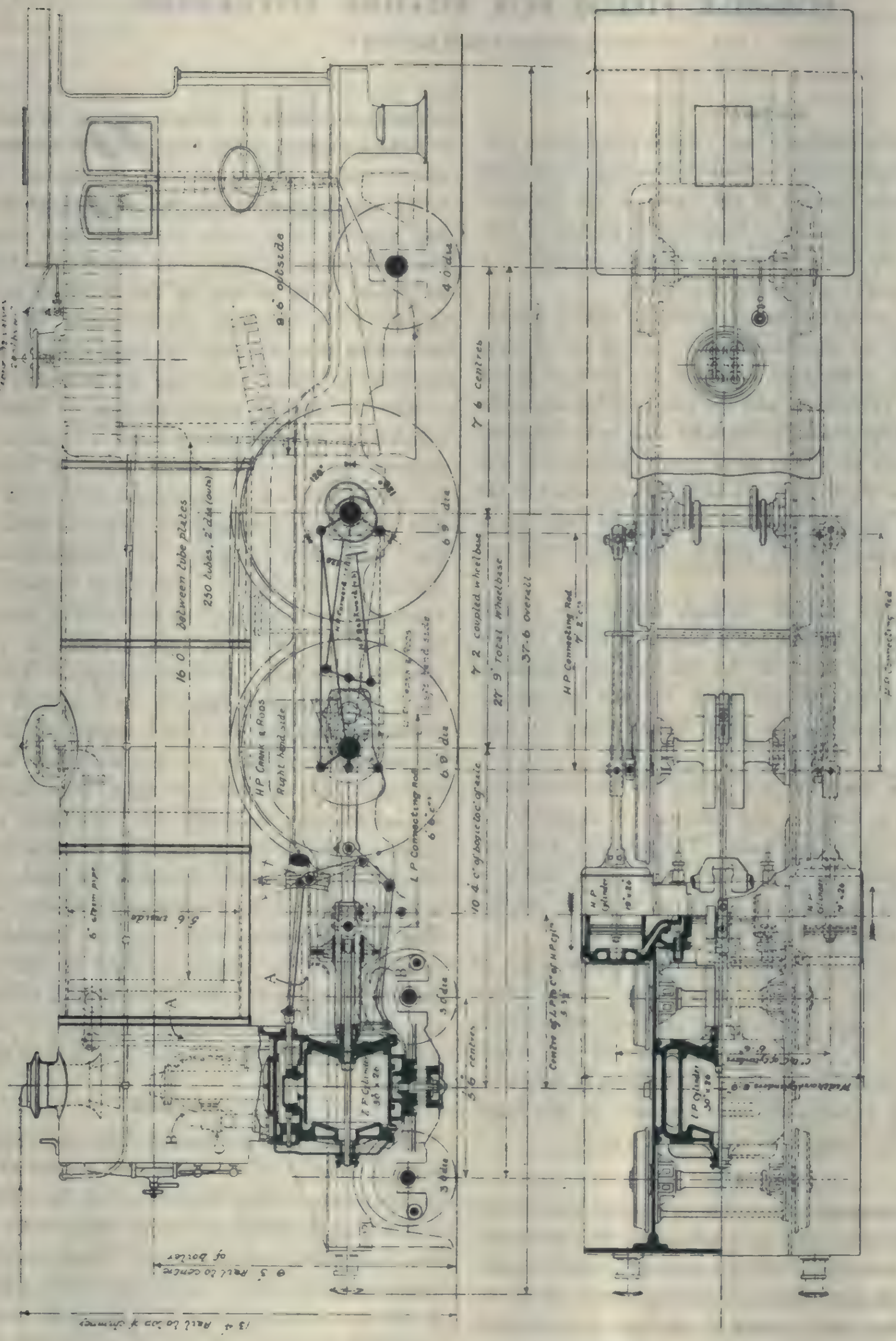


FIG. 1. THE AUTHOR'S DESIGN FOR A LARGE EXPRESS PASSENGER LOCOMOTIVE COMPOUNDED ON REIKIE'S SYSTEM.

"THE WORLD'S LOCOMOTIVES."

IN deciding to produce a fresh treatise on locomotive practice, the author of this book was making an incursion into a field already tolerably well covered. Previous writers have, however, been in the main content to confine their work to a particular branch of railway engineering, and in planning a comprehensive survey of the range of locomotive work, Mr. Lake opened up for himself the prospect of producing a book of real interest. A first reading leads to the conclusion that the task has been carried out with the thoroughness which was to be expected from a writer of such repute. The general scheme adopted is that of setting forth the particulars of contemporary locomotive designs during recent years, and by so doing, bringing into comparisons the efforts which are being made the whole world over to cope with the ever-increasing demand for more powerful engines for working railway traffic.

The opening chapters naturally are devoted to a brief survey of certain aspects of general practice, and to specific examples of locomotive design, comparative treatment of the whole subject being reserved for later chapters.

MODERN EXPRESS LOCOMOTIVES.

The problems involved in the work of designing a modern first-class locomotive for express passenger duty are many and complex. The maximum dimensions possible under the British loading gauge are, as the author points out, already being employed upon home railways, and although an ample margin of power does exist in the case of the largest locomotives, the point naturally arises as to what will be the next development if train loads continue to increase at their present rate. There are, of course, expedients which it is easy to adopt, but the objections to them both on the score of economy and complexity of working methods are very strong, and it will clearly be necessary to find means for still further increasing the power of the individual locomotive in order to keep pace with the growing necessity for hauling heavier train loads at the same, or even higher speeds than those reached at the present time. Difficulties in regard to cylinder and wheel arrangements are no doubt easily surmounted; the crux of the difficulty is the question of boiler power. As Mr. Lake shows very clearly, the question of heating surface is most important in considering the question of locomotive efficiency.

TRUE VALUE OF HEATING SURFACE.

The largest boilers used upon express passenger locomotives in this country to which Mr. Lake refers are those of the North-Eastern, where the total heating surface is 2,455 square feet, and the steam pressure 200 lb. per square inch. An opinion of the true value of heating surface can only be accurately formed, however, by an examination of the method in which it is obtained, and the author discusses this point in some detail. Larger boilers would, no doubt, solve a great difficulty on British railways, but the loading gauge forbids their introduction. Superheated steam is very little used on British railways, and it may be noted that experiments on the Lancashire and Yorkshire Railway did not lead to a general adoption of that principle.

The 4–6–0 wheel arrangement is popular in America and on the Continent, but the 4–4–0 wheel arrangement is still the most popular in this country. There are in all, however, some twenty-five different types of locomotives coming within the category of modern standards, both British and foreign, and it need not be stated here that the greatest assortment of types in any one country is found in America, where many of them originated. A considerable section of the book is devoted to a consideration of British types of engines, and we illustrate in fig. 2 an example from the latest British practice, a six-wheeled coupled bogie passenger locomotive designed by Mr. George Whale, chief mechanical engineer of the North-Western Company, for hauling heavy express trains on the Crewe-Carlisle section of that line. The cylinders of engine are 19 in. by 26 in. the coupled wheels 6 ft. 3 in. in diameter, rigid base wheel, 13 ft. 7 in., total base wheel, 26 ft. 8½ in. The total heating surface is 2,041 square feet, the grate area 25 square feet; the weight of engine in working order is 65 tons 15 cwts.

"The World's Locomotives." A digest of the latest locomotive practice in the railway countries of the world. By Charles S. Lake. With numerous Illustrations. Percival Marshall and Co. Price, 10s. 6d. net.

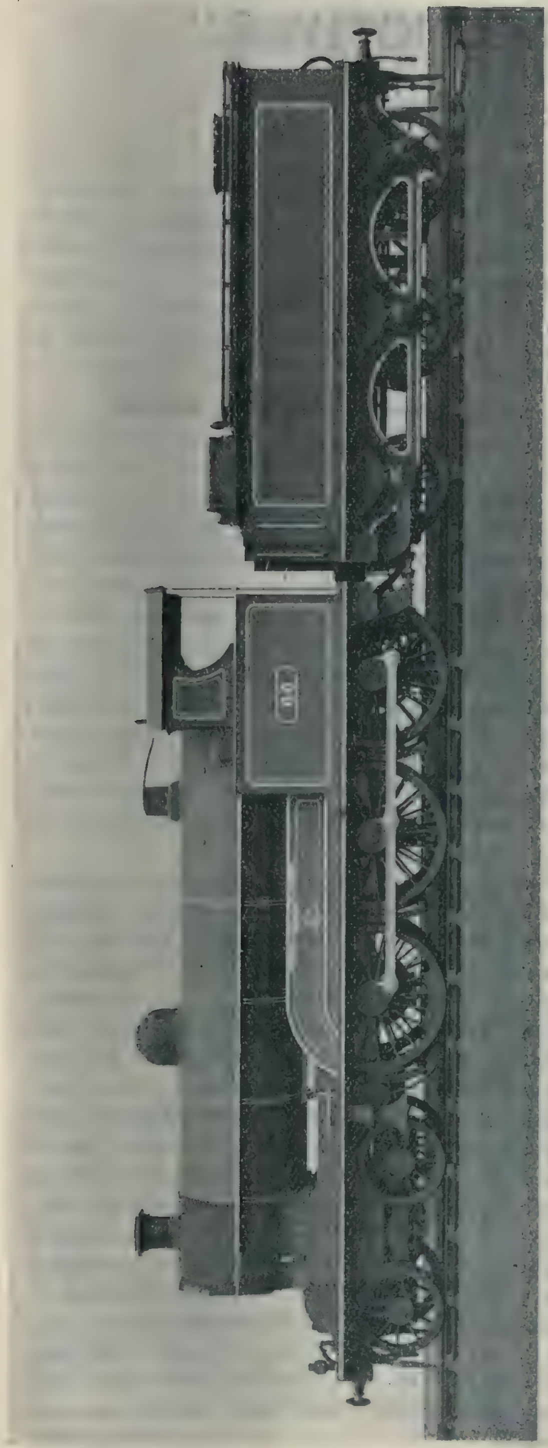


FIG. 2. SIX-WHEEL-COUPLED BOGIE PASSENGER LOCOMOTIVE, L. AND N. W. RAILWAY.

UNPOPULARITY OF THE COMPOUND TYPE.

In chapter IX. Mr. Lake discusses the unpopularity of the compound locomotive in Great Britain, a thing rendered inexplicable by the fact that abroad the compound locomotive is looked upon as the natural and most efficient kind of engine for working all classes of railway traffic. Statistics which cannot easily be disputed exist to show that results are being obtained on foreign railways with compound locomotives for which it would be difficult to find a parallel here, where the two-cylinder simple engine is the most popular type for all classes of service. Various systems of compounding are discussed, and Mr. Lake puts forward a design of his own founded on Reikie's system, which is illustrated in fig. 1.

REIKIE SYSTEM APPLIED TO MODERN LOCOMOTIVES.

It will be remembered that the Reikie compound system differs in one important respect from other systems in having a large high-pressure cylinder capacity. No locomotives have up to the present been constructed on Mr. Reikie's principle for use on a railway in this country, but an idea of the manner in which it is applied to modern express locomotives can be gathered from the drawing on page 354. The engine has the 4–4–2 wheel arrangement, and the low-pressure cylinder is located between the frames below the smokebox, driving the balanced crank axle of the first pair of coupled wheels. The high-pressure cylinders are placed outside the frames to the rear of the bogie, and drive the second pair of coupled wheels. The low pressure crank, it will be noticed, is set at an angle of 120 degrees to those of the high pressure. The suggested arrangement of valve gear is Joy's for the low pressure, operating a D valve above the cylinder, and ordinary Stephenson link motion for the high pressure, with D valves working at the sides of the cylinders. Steam, on being taken from the dome travels through pipes A and A^1 to the high-pressure steam chest, entering at the top of the latter. On being exhausted from the high-pressure cylinder it passes by way of pipe B to the low-pressure steam chest. A relief valve C provides a means of communication between the steam pipe and the blast pipe, coming into operation only when the pressure exceeds a certain predetermined limit.

TANK LOCOMOTIVES ON FOREIGN RAILWAYS.

An interesting section of the book is that devoted to Colonial, Indian and foreign locomotives. Attention is directed to the fact that Belgian locomotive practice gives very ample proof of being influenced by British principles of design and methods of construction. Grand Trunk engines are, of course, designed upon American principles. The feature of the Austrian system illustrated is that locomotive practice on the railways of that country is closely identified with the Golsdorf compound system, the distinctive feature of which is, it will be remembered, that no starting valve is required. The engines, which were designed for high speed and took part in the Marienfelde-Zossen speed tests, are also described, and in this section of the book various methods of superheating employed, the Pielock, Schmidt, and others are discussed. Tank locomotives are by no means so widely resorted to on foreign railways as in this country, but their use appears to be increasing, although the favourite British 0–4–4 type is seldom utilised.

AMERICAN PRACTICE.

The final chapter is devoted to locomotive practice in the United States. As the author points out, in the matter of boiler design, American practice has been developed to a stage ahead of most other countries which is principally accounted for by the lax limitations governing the matter of size. For working passenger traffic, locomotives of the 4–4–2 type are widely employed for the fastest services. The use of compound cylinders is largely resorted to, but by far the greater number of locomotives are adapted to single-expansion working. Four-cylinder balance locomotives have, however, been coming into favour recently. Engines employed for working goods or freight traffic are of a great variety of types, while American tank locomotives are noteworthy for originality of design.

The author has provided a very full index to the book, the scope and character of which have been briefly outlined, and it certainly ought to be in the hands of all those interested in locomotive problems.

TUNNEL CONSTRUCTION.

IN tunnel construction there is a great diversity of methods both in breaking the rock and in timbering the ground after the excavation has been made. In some tunnels the character of the rock passed through requires close and heavy timbering with lagging top and sides. In other cases the timbers may safely be spaced 5 ft. from centre to centre, and lagging employed only overhead, as in the case here illustrated. Often the roof only requires support, the walls standing without lagging. Where the excavation has been made in a flat, sedimentary formation caps have sometimes been inserted after the manner of stulls and tightly wedged, the lagging being driven overhead to support any loose ground that may occur. The method is not in common use, however, and in only a few places can it be rendered secure.

In soft and swelling ground, the practice is to spread the legs of each set abnormally so that they stand at an angle of 40 deg. to 45 deg. with the horizon. This has a tendency to keep them in position, and aids somewhat in resisting the crushing force of the slowly moving ground, but usually this expedient only affords temporary relief, and the timbers have frequently to be renewed, or the ground cut away to ease the pressure on the timbers. In many tunnels, after getting beyond the zone of weathered rock, no timbers are required, the rock being sufficiently hard to stand without timbers. In other instances rock which at first stands well, after a time, begins to disintegrate and numerous falls of the back occur. When these are of frequent occurrence, it is usually cheaper to timber all that portion of the tunnel in which these falls occur, for, having commenced, they are more than likely to recur with increasing frequency, and become a constant menace to life, as well as an annoyance and source of expense.

Tunnelling, says a writer in the Mining and Scientific Press, requires often nearly as much engineering skill and the exercise of as good judgment as shaft sinking. If care is used there is no reason for a tunnel getting out of alignment, though it is a very common thing to see careless work done, the heading swinging from side to side, and eventually running at random, first following one rock seam and then another, in the effort to follow easy ground. In one instance it was figured that at least 10 per cent. of the cost of mining was saved by following seams "to break to," but the tunnel was driven not less than one-fifth farther than necessary to reach a given point, so as a matter of fact it was really more expensive, and required a greater length of time to reach this point than if the tunnel had been driven perfectly straight.

At the meeting of Pease and Partners, Ltd., Sir David Dale stated that the company had raised 1,687,955 tons of coal during the past year, or 19,772 tons more than in the previous year; of ironstone 995,811 tons, or 38,772 more than in the preceding twelve months; and of limestone 374,084 tons, or 6,619 tons less. Thus the total of coal, ironstone, and limestone raised during the year was 3,057,919 tons—practically three million tons. The coke made during the year amounted to 637,368 tons, a slight decrease

OUR WEEKLY BIOGRAPHY.

MR. CHARLES ERNEST SPAGNOLETTI, M.Inst.C.E., M.I.E.E.

THE life of Mr. Charles Ernest Spagnoletti coincides to a remarkable extent with the development of railway telegraphy and the use of electric appliances. Born at Brompton in 1832, his professional career began in 1846, when he worked on the chemical printing telegraph and electrical clocks invented by Mr. Alexander Bain. This system was absorbed by the Electric Telegraph Company, to which firm Mr. Spagnoletti transferred his services. After taking charge of the various country branches for this firm, he entered, in 1855, the service of the Great Western Railway Company, and devoted his attention to the application of electricity to railway requirements and improvements. His book of rules and instructions for regulating traffic by the block system formed the foundation on which all lines are worked in this country; the scheme was also adopted by several foreign and colonial companies. Mr. Spagnoletti was the first appointed to the position of railway electrical engineer The advantages of such a department were soon made manifest, and other railway companies then made similar appointments, the benefits of which were in a few years confirmed by the reduction of accidents, the maximum of safety in travelling being secured to both the public and the officials. He used many electrical appliances to this end, amongst which may be named the induced coil for preventing the serious effects of lightning on needle telegraph instruments.

Photo, Elliott and Fry.

C. E. SPAGNOLETTI, M.INST.C.E., M.I.E.E.

The next improvement introduced by Mr. Spagnoletti was the electric block system, followed by the electric locking system which locks the signal levers and prevents the signals being used until the departing train has left the station in advance, thereby ensuring that another train cannot follow until the section is clear. This system is used on the Great Western, Metropolitan, City and South London, Central London and Great Northern and City Railways. In cases where railway signals are located out of sight of the signalman responsible for their manipulation, Mr. Spagnoletti introduced a "repeater," which is placed in the signal box over the lever showing if the signal arm is properly up, down, or wrong. Another patent of the same inventor indicates whether the lamp is burning properly, and in the event of its having become extinguished, the indicator rings a bell calling the signalman's attention to the fact, and shows "lamp out." Mr. Spagnoletti also brought out electrical fire alarms, tell-tale clocks, and other electrical appliances, and in 1870 he was responsible for the discovery of induction in overhead telegraph wires.

In the year 1885 he was unanimously elected president of the Institution of Electrical Engineers, and is also a corporate member of the Institution of Civil Engineers. He acted on the committees and juries of all the English electrical exhibitions at South Kensington, Crystal Palace, etc., and was on the general committee of the Chicago Exhibition, also on the Paris Exhibition Jury of 1878 and 1881. At the close of the exhibition of 1878, Mr. Spagnoletti was specially complimented by His Majesty the King (then Prince of Wales and Royal Commissioner).

He was consulting electrical engineer to the first electrical railway, the City and South London, and has had considerable experience on electric lighting, having had charge of the illuminating of Paddington Station, one of the large installations, and the City joint lines first between Mansion House and Whitechapel. The Phonopore telephone was perfected by Mr. Spagnoletti, who retired from the Great Western Railway Company in 1892 after thirty seven years' unusually active service.

MR. K. W. LUNDEBERG.

THE new Prime Minister of Sweden, Mr. K. W. Lundeberg, is prominently associated with the Swedish steel industry. Members of the Iron and Steel Institute who participated in the Swedish excursion of 1898 will not need reminding that he was one of the local reception committee at Stockholm, and that he also extended hospitality to a large number of members at his residence at the Forsbacka Steel Works near Gefle, of which at that period he was managing director.

TURBINE BLADES.

MANY experiments have been made into the wear of the blades of steam turbines to determine the cause of this trouble and the latest to conduct an investigation are the firm of Sulzer Bros. It is undoubtedly a fact that the continued success of the turbine hinges largely upon this one point of blade wear. If the blades of a particular machine should have to be renewed frequently, because of deterioration and consequent loss in economy in the use of steam, that turbine would not make a commercial success. The Sulzer experiments indicate that the wear is due to the particles of water in the steam, and that if water is present in steam that flows at extremely high velocities, as is the case in single-stage turbines, the cutting is apt to be rapid. With superheated steam, or with saturated steam in multi-stage turbines, the cutting is not a serious matter.

The above experiments are in a measure confirmed, thinks an American contemporary, by the experience of those using steam injectors for boiler feeding. This cutting action seldom occurs in the steam nozzle, but frequently does take place in the combining tube where water is flowing at comparatively low velocities. It should be noted, however, that this water is mainly the feed water pumped up by the injector, and contains more or less mineral matter, the extent of the cutting probably depending upon the quantity of such foreign particles entrained in the water. In the case of the turbine, however, the water particles suspended in the steam are or should be nothing but pure distilled water, formed by steam condensation after leaving the boiler. Probably no injector would give trouble by cutting, if used to pump distilled water, assuming, of course, that the tubes were of a material that would not be corroded by the water. It is thought that no turbine, in which the steam is used at moderate velocity, will be likely to deteriorate rapidly under ordinary operative conditions.

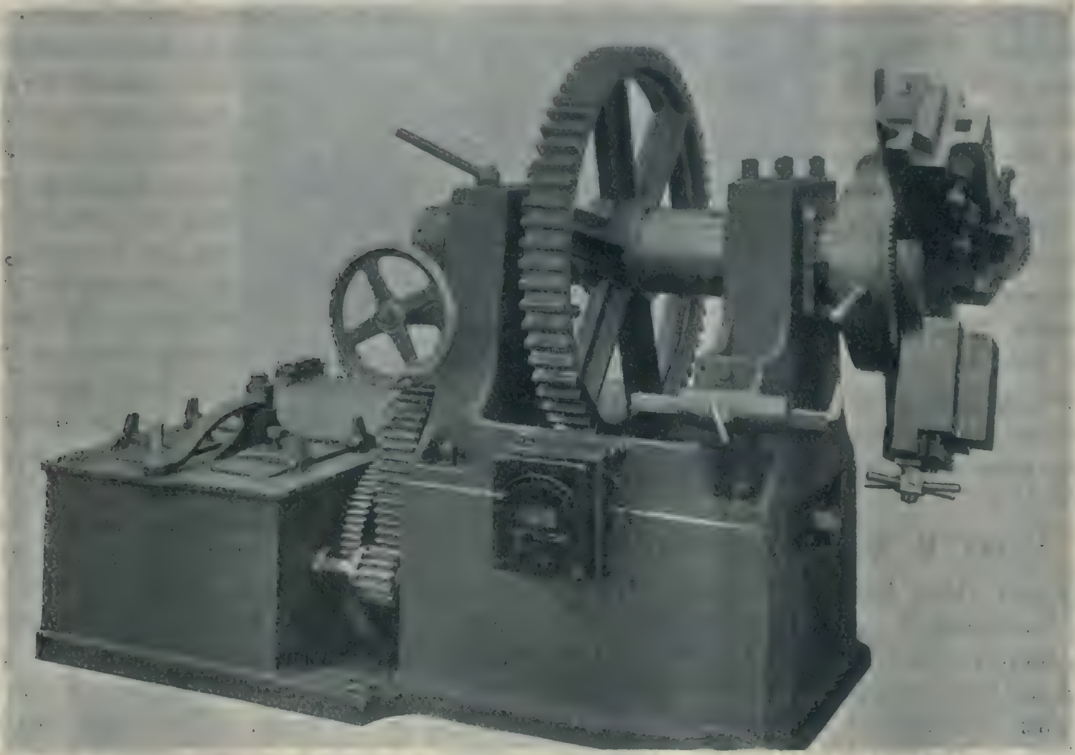
IMPROVED ELECTRICAL CUTTING-OFF LATHE.

BY MR. GEORGE ADDY, M.I.MECH.E., SHEFFIELD.

IN cast-iron pipe foundries of large extent the question of handling the output of the casting shop as little as possible in its progress from the rough pipe as it leaves the mould to the finished pipe as it leaves the works, is one which is ever present to the up-to-date manager. In order to save the cost of conveying the pipes from the fettling shop to the lathe (for the purpose of trimming up the rough end of each pipe) it is becoming more general to avoid this waste of time by putting down in the fettling shop a cutting-off lathe, electrically-driven, so that the absence of line shafting is of no consequence.

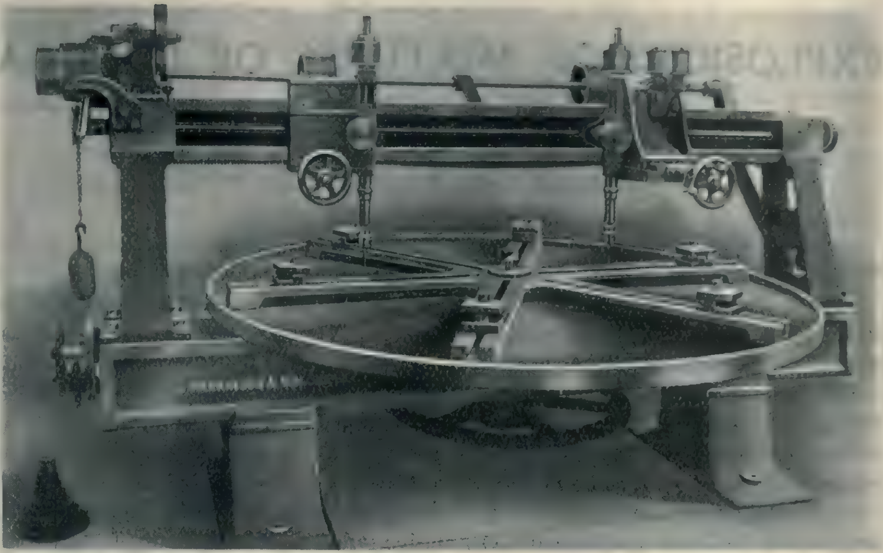
The latest development of this arrangement is illustrated below.

In this lathe designed for cutting off the ends of pipes up to 12 in. diameter, Mr. George Addy, of Sheffield, has placed upon the market a very compact and efficient tool. The headstock, gear box, and motor are all mounted on one casting, which makes the tool very rigid and compact, and being electrically driven it can be readily fixed up in any position. The machine is driven by a 5-b.h.p. continuous-current motor, which communicates with the gear box. The gear box is arranged with three speeds, and the alteration of speed is effected by the cranked lever at the top. Suitable doors are provided for lubricating the gearing. The motion is transferred from the gear box by suitable



IMPROVED ELECTRICAL CUTTING-OFF LATHE.

gearing to the spindle, upon which is secured Addy's patent three-tool cutting-off chuck.



AUTOMATIC TWO-SPINDLE DRILLING MACHINE.

The new feature of this cutting off chuck is, that each tool is moved towards the centre simultaneously and equally by a star wheel and kicker. The spindle has an inward movement of 3 in. and is graduated. The kicker is also graduated so that whatever point in the graduation the spindle indicates, the kicker must indicate the same. In this way no time is lost in finding the position of the kicker to give the required amount of self-acting feed.

When the pipe has been cut off the tools are withdrawn by hand simultaneously and quickly by the large star wheel on boss of chuck. A suitable electric starting switch is provided.

AUTOMATIC TWO-SPINDLE DRILLING MACHINE.

AN automatic two-spindle drilling machine has been designed by Messrs. J. Parkinson and Son, of Shipley, Yorks., to meet the requirements of special work. We illustrate it above. It is intended for automatically spacing and drilling holes in steel discs from 4¾ in. to 57¾ in. diameter, the largest hole to be drilled being $\frac{9}{16}$ in. diameter and the maximum thickness of metal ⅞ in. It will be seen from our illustration that the two drilling heads are carried on a cross rail. Both the heads can be fixed at any position along the rail, so that holes can be drilled at different radii from the centre of the disc. The head shown at the right has also an adjustment of 4 in. at right angles to the rail. The drill spindles are driven by belts off pulleys which slide along a shaft at the rear. This shaft is driven from an overhead countershaft by belting on to the three-cone pulley shown at the end of the rear shaft. The feed motion of the drilling spindles is also driven from the rear shaft, and the point at which the automatic feed commences can be regulated. Arrangements have also been made to enable the drills to be fed to or from the work by hand if desired. The maximum traverse of the spindles is 1¼ in., and after this amount of movement they return automatically, and the circular table of the machine carrying the discs to be drilled is also automatically rotated by means of mechanism situated at the back of the machine. The only part of the spacing mechanism which can be seen in the illustration is the dividing wheel on the vertical spindle carrying the table. The different divisions that are required are obtained from suitable change gears. Six radial T slots are provided on the table, with clamping dogs in each for securing the work to be drilled and the spacing mechanism. The approximate weight of the machine is 2 tons 1½ cwt. The various handles and controlling levers have been placed in convenient positions, and the work can be handled with a minimum amount of trouble.

EXPLOSIONS OF MIXTURES OF COAL-GAS AND AIR IN A CLOSED VESSEL.

By Leonard Bairstow and A. D. Alexander.

THE work here described, representing more than two years' continuous work, had for its original object the determination of the explosive properties of compressed mixtures of coal-gas and air.

The main apparatus was designed by Messrs. McDiarmid and Mann, students of the Royal College of Science, South Kensington, and was made before the authors of this paper became connected with the work.

In the preliminary experiments it was found necessary to mix the gases independently of diffusion, and most of the experiments have consequently been made at an initial pressure of 35 lb. per square inch absolute, as this allowed a considerable volume of air to be pumped into the cylinder after the coal-gas had been admitted. Eventually it was found necessary to take still greater precautions in special cases, and mechanical mixing was resorted to.

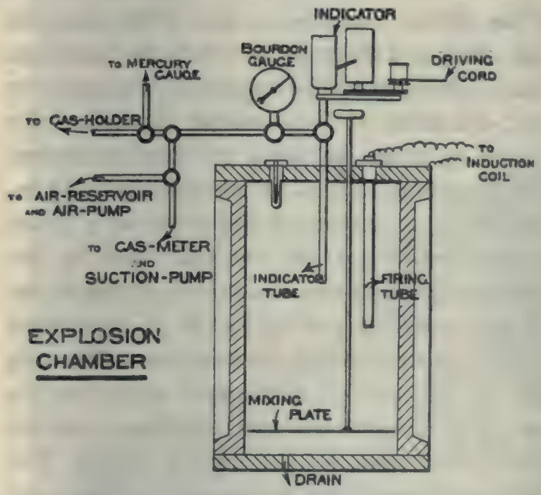


FIG. 1. ARRANGEMENT OF APPARATUS.

Figure 1 shows the explosion cylinder, which was 18 in. long and 10 in. in diameter internally. The records were taken with an ordinary indicator, the spring being usually 150 lb. per square inch per inch. The recording drum was made to revolve continuously at a speed giving 42·5 in. of diagram per second. By varying the firing arrangements the mixtures could be ignited at different points, and a further deviation from previous work was made by altering the length of the tube which led to the indicator. The firing tube shown in the figure was closed at the top where the spark was produced, and communication with the cylinder took place through a pin-hole near the bottom. The proportion of coal-gas to air was kept constant, and using the above tube the mixture was fired at different points. In general, changes resulted both in the time of explosion and in the maximum pressure.

For the most explosive mixture the change in the maximum pressure was small, being only of the order of 1 per cent., but in weak mixtures the variations sometimes exceeded 30 per cent. Such differences can only be observed in a vessel which absorbs heat, but it does not thereby follow that the differences are entirely due to the heat lost by the gases before the highest pressure is reached, since the maximum pressure does not coincide with the end of combustion when the rate of cooling approaches the rate of reception of heat by explosion. This and the cooling loss can be differentiated in some of the diagrams obtained, and the experiments were used as a guide to correction.

Convection currents were also indicated by the method of firing by explosions starting at the bottom of the cylinder being quicker than an otherwise similar one beginning at the top. The currents are sometimes very considerable.

In order to reduce the cooling effects, the explosion was often commenced at four points in the axis of the cylinder. The four spark-gaps were in one continuous circuit, and the sparks, therefore, occurred simultaneously. Keeping the initial pressure constant the mixture was varied. The highest pressure and the most rapid explosion was produced when the oxygen of the air was just completely burnt. The pressure fell continuously as the proportion of coal-gas to air was diminished, until the fractional volume of the mixture occupied by the coal-gas was about 1 in 12. A sudden change then occurred, and combustion remained incomplete after explosion. Mixtures between 1 in 12 and 1 in 17 were still explosive but the amount of gas burnt decreased, at first suddenly and then regularly, until the limit of inflammability was reached.

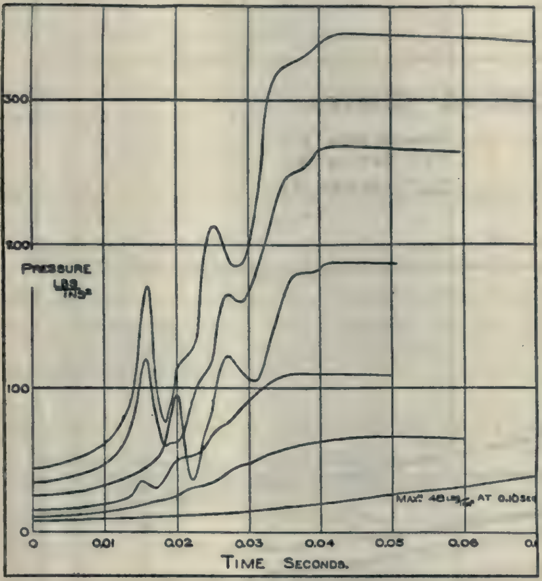


FIG. 2. INITIAL PRESSURE VARIED FROM ½ TO 3 ATMOSPHERES.

If then, the gases remaining in the cylinder, after an explosion of a mixture less rich in coal-gas than 1 in 12 were used instead of air in a subsequent explosion, higher pressures should result. This was observed to be the case, and with a necessary modification furnishes the explanation of the experimental results obtained by Mr. Grover in 1895.

Diagrams taken show ripples between the beginning of explosion and the time at which the maximum is reached. It is obvious that they are not due to the inertia of the indicator. With four sparks or a single spark at the top of the cylinder these occur early in the diagram, and are not usually very noticeable. When, however, the point of firing is altered, the change is accompanied by a difference in the position of the ripples. A measurement of them, when sufficiently uniform to be measured, showed that the period was independent of the pressure at which they occurred, and eventually they were traced to sound waves in the indicator tube produced by the arrival of the flame at its open end.

When the ripples occurred at the maximum pressure the amplitude was sometimes enormous, the extra pressure due to the ripples being often as great as the pressure due to combustion in the cylinder. This phenomenon is probably connected with the detonation wave investigated by MM. Mallard and Le Chatelier and by Professor H. B. Dixon. There is no evidence of the detonation wave in the cylinder itself in any of our experiments. The big movements are never found with weak mixtures, or even in rich mixtures fired with short tubes.

With weak mixtures, even when combustion is complete after explosion, the ripples indicate that the flame travels through the more inflammable portions of the mixture first, and therefore that the constituents burnt successively. This type of combustion can be detected until the coal-gas occupies more than one-eighth of the volume of the mixture.

EXPERIMENTS ON COMPRESSED MIXTURES.

These experiments form an extension of the well-known work of Mr. Dugald Clerk.

The arrangement of four sparks was found to produce the most consistent results, and it was then noticed that slight changes in the composition of the coal-gas affected the experiments, particularly the rate of cooling. To make comparative experiments, therefore, it is necessary to do them at the same time and on the same gas. Three series are given, each the result of one day's experiments. The gas used in the first two is the same, but different to that used in the third series. Series 1 is shown in figure 2. Mixture constant (volume of coal-gas divided by the volume of air = 0·168). Initial pressure varied from ½ to 3 atmospheres.

Series 2 in fig. 3. Mixture constant (0·105). Initial pressure as in Series 1; and Series 3 in fig. 4. Initial pressure constant. Mixture varied.

From fig. 2 it will be seen that for a mixture of 0·168 the time of explosion is almost independent of the initial pressure between one and three atmospheres, but considerable increase is noticed for the two lower pressures. Similarly, between the same limits the ratio of the maximum to the initial pressure is constant. With the weaker mixture the time of explosion increased as the initial pressure decreased, without

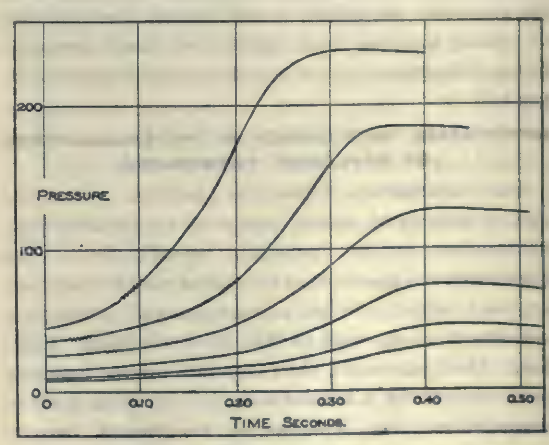


FIG. 3. SECOND SERIES OF EXPERIMENTS, INITIAL PRESSURES AS IN FIRST SERIES.

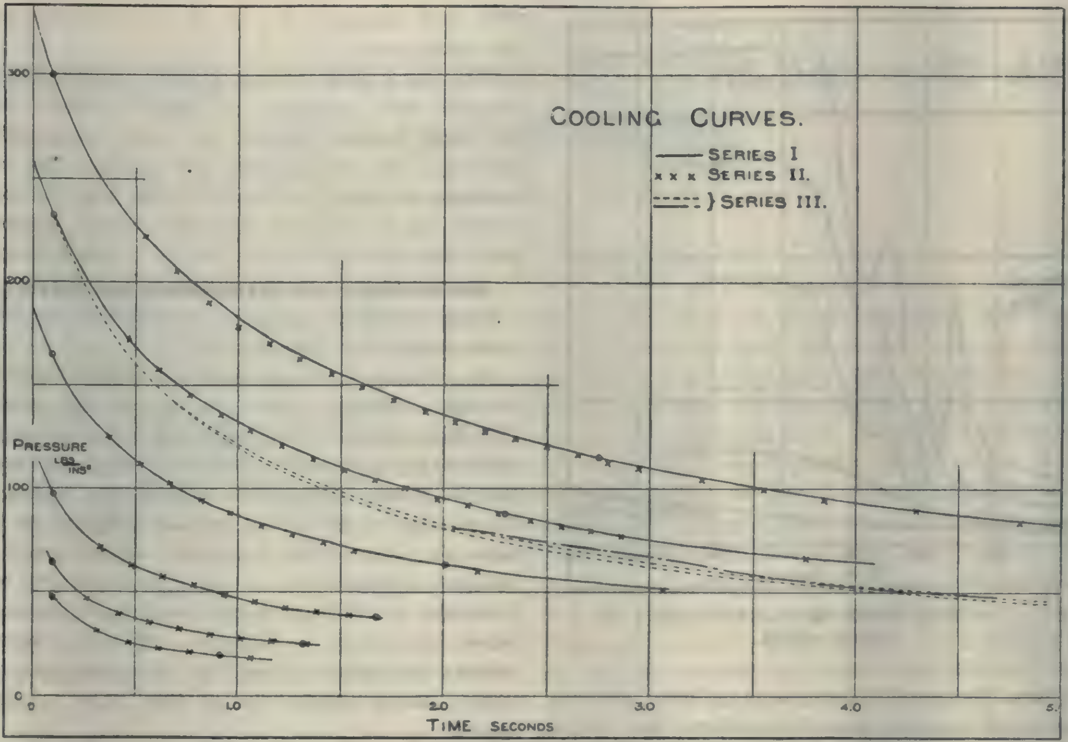


FIG. 5. SHOWING THE COOLING CURVES FOR THE THREE SERIES, ON THE ANALYSIS OF WHICH IT WILL BE SEEN THAT THE RATE OF COOLING INCREASES WITH INCREASE OF INITIAL PRESSURE.

any decided effect on the ratio of the maximum and initial pressures (fig. 3).

The mixtures for Series 3 are such that the volumes of coal-gas burnt increase in arithmetical progression. These experiments show clearly that the heating value of unit volume of coal-gas increases as the mixture gets weaker (fig. 4).

Fig. 5 gives the cooling curves for the three series. By analysing the curves it will be seen that the rate of cooling increases with increase of initial pressure, but is independent of the relative proportions of coal-gas and air.

HYPOTHESES INTRODUCED IN THE CALCULATION OF EXPLOSIVE PHENOMENA.

The outstanding differences between calculated and experimental results can now be explained by dissociation or an increasing specific heat. The hypothesis of a specific heat increasing with temperature is based entirely, so far as experimental evidence is concerned, on the work of MM. Mallard and Le Chatelier. They examined their cooling curves carefully in the search for a discontinuity at the lower limit of dissociation. Fig. 6 shows an analysis of two of their curves. The lower curve shows the discontinuity in question at C. In both explosions concerned in diagram 6, the products are the same both in composition and mass. In comparing results during cooling, therefore, equal pressures mean equal temperatures. The rate of loss of pressure divided by the pressure is shown as the ordinate of the figure and the ratio of the two ordinates for any given abscissa, therefore gives the ratio of the rates of cooling in the two cases. Where W – Po is 300, the rate of cooling in one case is 50 per cent. greater than in the other.

The only apparent difference between two such cases lies in the maxima reached, and the only other experiments which afford any evidence on this point agree in showing that the higher the maximum pressure and temperature, the lower the rate of cooling at any given subsequent temperature and pressure. The rise in the temperature of the cylinder walls would produce just such a change. A mathematical and experimental investigation showed that the metal itself does not increase in temperature greatly, and a film must therefore exist on the surface which sometimes attains a temperature of several hundred degrees centigrade. Such an hypothesis satisfies all the observed experimental conditions, whilst it would be exceedingly difficult, if not impossible, to explain either the upper steep part of the curve in fig. 6, or the

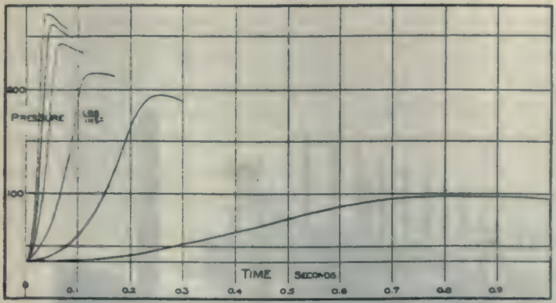


FIG. 4. SHOWING THAT THE HEATING VALUE OF UNIT VOLUME OF COAL-GAS INCREASES AS THE MIXTURE GETS WEAKER.

difference in the rates of cooling for the two cases, on the idea that C is the limit of dissociation.

Experiments at ordinary temperatures have not shown any such increase in specific heat as is necessary for the above hypothesis.

In order to determine the fraction of heat developed the composition of the coal-gas and its calorific value were obtained. For the richest mixture (0·184 of coal-gas to 1 of air) the pressure obtained was 65·7 per cent. of that calculated. This fraction increased as the mixture was weakened, and was about 80 per cent. when combustion became incomplete. The highest temperature for the richest mixture is 2,430 deg. C. absolute, and the heat developed 63·2 per cent. On the hypothesis of increasing specific heat, the temperature would be 6 per cent. greater.

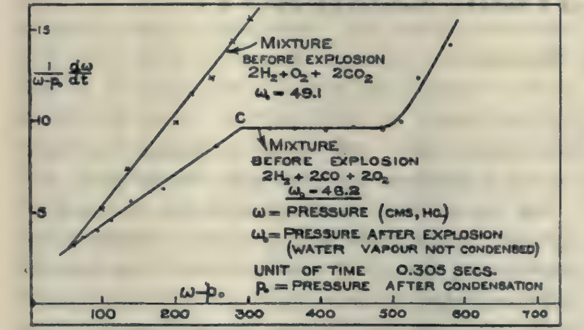


FIG. 6. SHOWING AN ANALYSIS OF MM. MALLARD AND LE CHATELIER'S CURVES.

SUMMARY.

Mixtures of coal-gas and air are not inflammable until the volume of coal-gas is greater than one-seventeenth of the combined volumes. Only a very small fraction of the gas then burns, the amount burnt rapidly increasing with increased richness of the mixture until the coal-gas is one-twelfth of the total volume. The least inflammable of the constituents then burns, and combustion becomes and remains complete so long as air is in excess. In these latter cases it is still probable that the constituents burn successively and not simultaneously.

The hypothesis of a specific heat increasing with temperature is not supported by direct experiment, and cannot be proved by any work on the pressures produced by explosion, the authors believing that a proof would require the measurement of temperature.

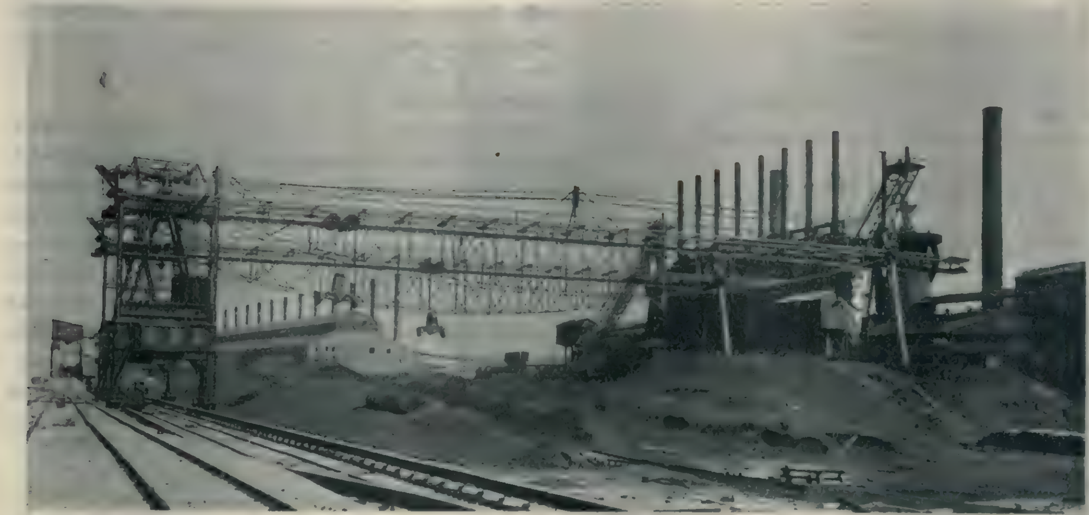
Direct experiments by Deville at temperatures below 1,400 deg. C. have shown that both steam and carbon dioxide are partially decomposed, and this dissociation is therefore taken by us as the sole explanation of the difference between the pressures calculated for explosions in a closed vessel and those actually obtained.

Abstract of paper read before Royal Society.

TECHNICAL EDUCATION.

WE have received from the City and Guilds of London Institute a proof of the syllabus in motor-car engineering issued by the department of technology. Examinations will be held at the end of each year's course, and the examination will include questions on subjects connected with the construction and operation of the whole of the mechanism of petrol cars, steam cars, electric carriages, and garage systems. Candidates for Honours will be required to show a knowledge of thermodynamic principles of the internal combustion motor; methods of determining flash point; density, and calorific value of petrol; indicating a petrol motor; Hospitalier-Carpentier indicator; measurement of mechanical efficiency; numerical examples in connection with adiabatic and isothermal expansion; deduction of empirical law of expansion from a given expansion curve and properties of materials.

The City of London College is opening an advanced commercial department next month. The object of this department, which will form part of the scheme for commercial education, inaugurated at the opening of the new buildings of the College, is to provide a higher education for those who have already had an ordinary secondary education. Hitherto there has been some basis for the charge that whatever existing higher education may have done for students in providing them with knowledge, whether of science, literature, or history, and whatever it may have done in training their mental powers and developing their characters, it has not generally induced them to regard business sympathetically, nor has it exhibited a commercial career in its true light.



GENERAL VIEW OF THE CLAIRTON PLANT.

ORE-HANDLING PLANT AT THE CLAIRTON WORKS OF THE CRUCIBLE STEEL COMPANY.

BY CHAS. H. WRIGHT.

ONE of the largest of the plants recently built is that of the Crucible Steel Company, at Clairton, just above McKeesport, on the Monongahela River. The plant at present consists of twelve 50-ton open-hearth furnaces, but is laid out with a view to a doubling of this capacity in the future should the demand warrant it.

The machinery of the furnace hoist was built by the Otis Elevator Company, and the furnace top is of the double-bell type, as used by Julian Kennedy. There are at present two prominent types of furnace tops, one of them the two-bell arrangement, and the other the rotating distributor type, as built by the Brown Hoisting Machinery Company.

The plant recently designed and constructed by the Brown Hoisting Machinery Company for the handling of material, ore, limestone and coke, at Clairton, is described and illustrated in this and following pages.

There is an electrically-operated car dumper, which handles about thirty 60-ton cars per hour. The moving load, including the car itself, is 160,000 lb. The material is dumped into a bin of 150 tons capacity, at the side of the tipple, from which bin it is drawn by means of spouts and gates, operated by a small motor, into bucket cars. The tipple is operated by two 130-h p. motors, and is of the regular Brown type.

The second item is a system of six electrically-operated transfer cars and a suitable equipment of self-dumping tubs of 7½ tons capacity. The transfer cars are arranged to run in pairs, each car being supplied with 35-h.p. motors, one car having a small cab, in which are placed the controller and mechanism for operating the cars. Each car carries two buckets. Current is supplied to the motors operating these cars by conductors of two 1½-in. square wrought-iron bars. The current is taken from these conductors by means of sliding shoes at the end of an ordinary trolley arrangement. These transfer cars take the material from the bins at the tipple and transfer it to any convenient point along the front of the yard, from which the buckets are picked up by the bridge, and the material is dumped either on the stock pile or into the storage bins.

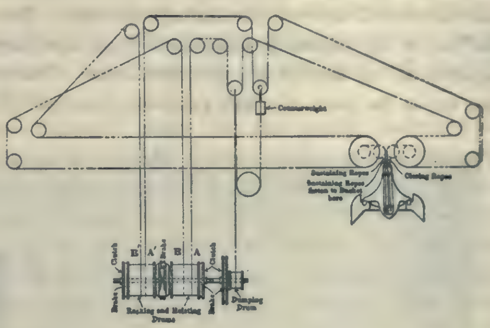
TRAVELLING ELECTRIC BRIDGE TRAMWAYS.

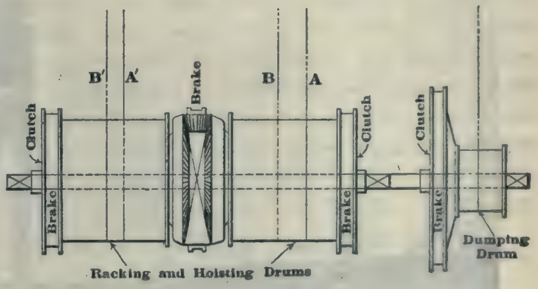
There are two of the Brown patent travelling electric bridge tramways, having a span of 300 ft., a cantilever extension of 46 ft. over the bins and a short extension t the pier, the extreme length of the bridge being 369 ft. Two 130-h.p motors are provided for each bridge, and one operator controls all the movements of the buckets and the trolley, and the travel of the bridge itself along the yard. The moving load on the bridge is 24,500 lb., and the engines are designed to move this load along the bridge at the rate of 1,000 ft. per minute and to hoist the bucket at 350 ft. per minute The travel of the crane itself along the tracks is about 75 ft. per minute. The bridges are designed to handle 7½-ton stocking tubs, or to take material from the stock pile and deposit it in the storage bins by means of 7½-ton shovel buckets or 5-ton two-rope grab buckets. The bridge operates on what is known as the rope system; that is, the movements of the buckets and of the trolley are controlled by ropes running from the trolley across the bridge and down the pier to the drums in the engine house. During the last year or two there has been a tendency to replace this rope system by what is known as the man-trolley arrangement. With the man-trolley plan the operator rides on the trolley, and all the mechanism for operating the buckets and the trolley is also placed on the trolley. The first advantage of this plan is that the operator is always at the point where he is working, and can see exactly what is being done. The second advantage is that a large percentage of the ropes and expensive sheaves, bearings, and supports are dispensed with. On the bridges at Clairton there are approximately 2½ miles of rope on each machine. These ropes and their supports are, of course, an expensive item to instal and keep in repair. An objection to the man-trolley system is the fact that the moving loads of the structures are increased from 2 to 2½ times over those where the rope system is used, and a very much heavier structure is necessary. There are many points which could be mentioned in favour of both systems.

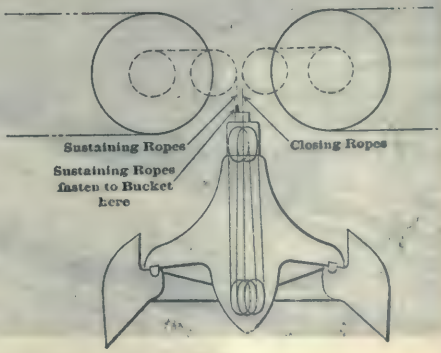
EVOLUTION OF THE GRAB BUCKET.

During the last two or three years many have been working to design a grab bucket which would successfully handle ore. A bucket may handle coal very successfully, and yet a bucket built on the same lines may be a perfect failure when it is attempted to use it in ore. Some of the first buckets designed to handle ore were arranged to work on the same principle as the orange-peel bucket used in dredging. This was not a success, and later buckets have been designed to act first as a scraper, scraping together a load of ore, and then picking it up. There are several buckets now on the market doing successful work. The Mason and Hoover Company has a bucket which works very efficiently. I should say this bucket would take 95 per cent. of the ore out of an ordinary boat.

There are two types of grab buckets, known as the two-rope and single-rope types. In the two-rope system there is a set of lines attached to the shell of the bucket, and the second set is attached to the blades by means of sheaves and suitable mechanism. By pulling up on the lines which are attached to the blades a load of ore is taken up, and the bucket is carried on these lines to the point where it is to be dumped; the load is then thrown over on the lines which are attached to the shell, and, by releasing the closing lines, the bucket is opened and the load is dumped. In the single-rope system there is no line attached directly to the shell, and, for most of these buckets, a second man is required to release the blades when the bucket has been opened, or to adjust the mechanism for closing the bucket again. There has



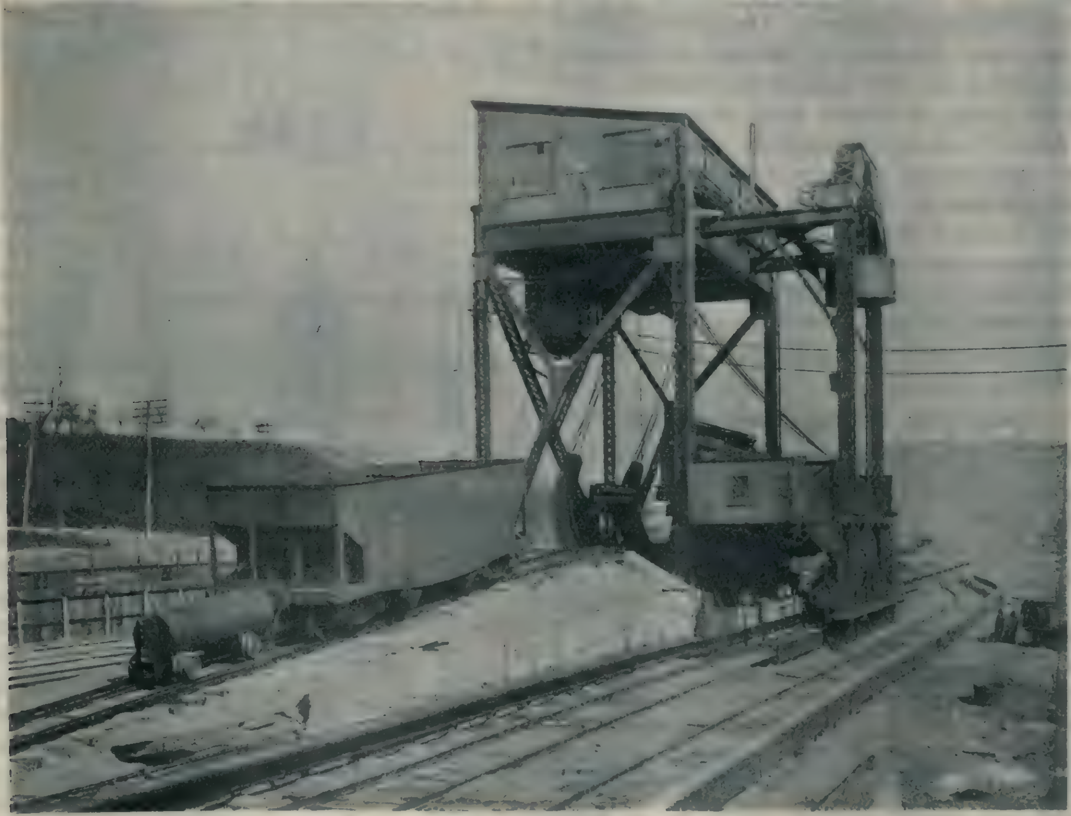




been recently perfected and put on the market a single-rope bucket which does away with this extra man. One of the most serious difficulties with which the makers of ore-handling machinery have to contend is the difficulty of reaching the ore between the hatches of a boat. It has been necessary to keep a gang of shovellers moving this material out under the hatches where the buckets can reach it. This difficulty has been overcome by the great Hulett machines, working at Conneaut, Buffalo and other places, by attaching the bucket to a vertical arm which rotates and also has a side motion, allowing it to carry the bucket underneath the framing between the hatches. This plan has been very successful in tis working.

PARABOLIC SUSPENSION ORE BINS.

There is a system of storage bins about 710 ft. in length. These bins are arranged in a double line, one line being used for the storage of ore and limestone, and the second line for the storage of coke. The ore bins are of the parabolic suspension type, and have a capacity of 13½ tons of ore per lineal foot. The coke bins are in the form of a half parabola, one side of the ore bin also forming one side of the coke bin, effecting a considerable saving in material. The bins are divided into pockets of about 14 ft. each. Of the pockets nearest the furnace, as many as necessary are reserved for the storage of limestone. There are two lines of railroad tracks on top of the bins, and all the coke is brought up to this point and dumped directly from the cars into the pockets. The ore and limestone can also be dumped directly from the cars if this is desired. The sides of the bins are usually protected by either wooden or brick walls to prevent the ore from freezing in the winter. The ore is drawn from the bottom of the bins into the larry. Underneath the bins are two tracks on which these larries run. The spouts under the bins are arranged alternately so that the ore can be drawn off into the larries on either track as desired. These spouts are usually operated by electric power. The controlling mechanism is also so arranged that the operator, at any gate, can start and stop the motor, so that the motor runs only while the gate is being used. In some of the later bins, the motor for operating the gates and most of the mechanism has been placed on the larry. This



THE BROWN PATENT CAR DUMPING MACHINE.

is the most satisfactory arrangement which has yet been installed for operating the gates.

The fifth item is the larry equipment for transferring the material from the storage bins to the skip-car. by means of which it is taken to the top of the furnace, The tracks on which these larries run are sometimes suspended from the bins, an I-beam being used for the tracks and the wheels of the larry running on the flanges. In other cases, I-beams or girders, with a railroad rail on top, are used, and in this case the track is placed 4 ft. above the ground. In some cases the suspended track is preferable, and in some cases the regular rail construction is better.

The larries will run the full length of the bins, and can take material from any bin and load it into the skip at any furnace. Ordinarily there would be two ore larries and one coke larry at each furnace. Only one operator is required to draw the material from the bins into the larries. There are two small motors on each of the ore larries, one for operating the bin-gate mechanism and the other for moving the larry. Different types of these larries arein successful operation.

The weight of the car dumper at Clairton is about 650,000 lb.; the weight of each of the bridges is approximately 700,000 lb. Each pair of transfer cars weighs approximately 30,000 lb. The weight of the bins, complete, is in the neighbourhood of 3,300,000 lb., the weight of the larries about 16,000 lb.

We illustrate on previous page the Brown patent car dumping machine, capable of unloading cars of all types at speeds up to 20 cars per hour. The cars, having a capacity of 30 to 40 tons each, are hauled up into the cradle and returned to sidings entirely by the machinery of the dumper and without use of shunting engines.

The general arrangement of the yard is as follows:—

Next to the railroad tracks, which are on the side of the yard farthest from the line of furnaces, there is a storage yard of large capacity for storing loaded cars, and also for the storage of the empty cars after they have left the car dumper. At the side of this storage yard next to the furnaces is a track on which the car dumper is placed. A system of switches enables the cars to be run in from any storage track on to the track leading to the tipple. The loaded cars, after they have been pushed down, either by locomotive or by gravity, to a point near the tipple, are pushed up an incline into the tipple by means of a "ground hog" or disappearing car, which runs into a pit below the track, enabling it to get out of the way of the loaded cars. After a car has been run into the tipple and dumped, the "ground hog" pulls another car up on to the incline and into the tipple, pushing the car just dumped out of the way,

DETAILS OF WORKING ARRANGEMENTS.

The tracks for the transfer cars run along the yard parallel to the storage track, and are so arranged that the loaded cars, after leaving the storage bin at the tipple, are automatically switched back on the track underneath the pier of the bridge, and, when the buckets have been emptied by the bridge, the train of empty cars continues on down the track to the end of the storage space, and is then switched back on to the track which takes them underneath the bin again, the switches being so arranged that they are thrown automatically, no switchmen being required.

Between these transfer tracks and the storage bin at the furnaces is a space about 300 ft. in width and 1,000 ft. in length, which is used for the storage of the various kinds of ore and limestone. This entire space can be covered by either bridge, so that if desired both bridges can be working upon the same kind of ore at the same time, or one bridge can be unloading ore on to the stock pile, while the second bridge is either loading ore from the transfer system into the bins direct or is taking ore from the stock pile and supplying the bins.

The runway tracks for the bridge tramways are arranged to straddle the bucket car tracks, the tipple being placed at one end of the yard, so that no crossings are required for the bucket car tracks over the crane tracks. In other works, the transfer cars never have to cross the tracks which carry the bridge tramways.

Only one operator in the house on each bridge tramway is required for the handling of either the dumping tubs, shovel bucket or grab bucket, and, when the bridges are using either the shovel bucket or the grab bucket, only one man is required for the handling of the ore from the stock pile into the bins. When the transfer cars are being used, two men are required on each train of cars, to hook on and unhook the tubs, and a third man is usually employed to move and control the train of cars.

Abstract of paper read before Civil Engineers of Cleveland.

The Imperial Steel Works at Wakamatsu, Japan, are turning out rails, bars, plates, and angles in quantities, and machinery is being ordered for the production of telegraph wire, rivets, bolts, nuts, etc. At present the whole of the production goes to meet Government requirements. It is probable that, but for the war, most of the rails imported during the past year would have been manufactured in Japan, at these works. About 18,000 tons of 60-lb. rails were manufactured there for use in building the military lines in Korea, besides many thousand tons of lighter rails.

TORPEDO-BOAT DESTROYER "MAGNE" BUILT BY MESSRS. JOHN I. THORNYCROFT FOR THE SWEDISH GOVERNMENT.

SHIPBUILDING NOTES.

Messrs. John I. Thornycroft and Co., Ltd., recently launched at their Chiswick Works the torpedo-boat destroyer *Magne*, built by them for the Royal Swedish Government. She is a vessel of the *Shirakumo* type, which has proved itself so successful in the present Russo-Japanese war. She has a guaranteed speed of 30½ knots; to be maintained for three hours with a load of 55 tons on board. The vessel is 219 ft. 9 in. long overall, 20 ft. 9 in. beam, and has a draft of 8 ft. 3 in. at the screws. The machinery, which is over 7,200 i.h.p., consists of two sets of four-cylinder vertical triple compound condensing engines and four Thornycroft water-tube boilers, worked under forced draft on the closed stokehold principle. The bunkers have a capacity for 80 tons of coal, giving a radius of action of 2,800 nautical miles at a speed of 15 knots per hour. A signal mast, with derrick, topmast and yard, is fitted forward, and can be hinged down on deck when desired. There are three boats carried on davits, one being a Thornycroft petrol motor gig 22 ft. long, with 10-b.h.p. motor; the other boats are respectively an 18-ft. cutter and a 14-ft. dinghy. Accommodation is provided for 64 officers and men; each officer having a separate cabin. The armament consists of six 57-millimetre quick-firing guns, one mounted on the conning tower, one aft, and four on the broadside. There are also two 45-centimetre revolving torpedo tubes. The boat is extensively subdivided into watertight compartments by transverse bulkheads and watertight decks under the living spaces.

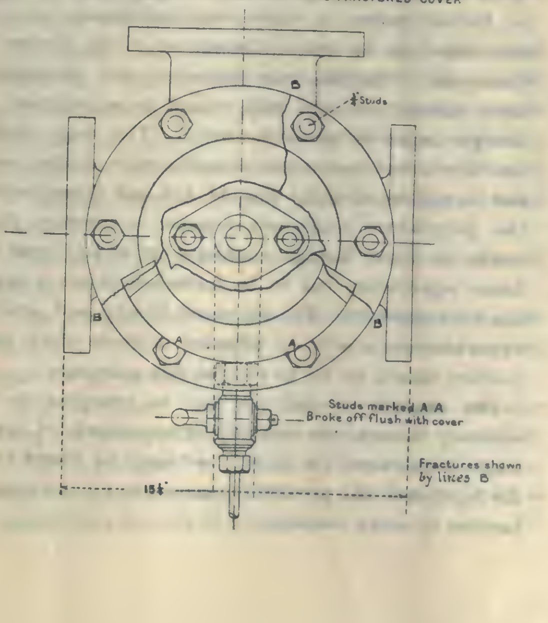
The *Mahronda*, the first of four new vessels building by Messrs. Harland and Wolff for the well-known firm of Messrs. T. and J. Brocklebank, Ltd., of Liverpool left Belfast harbour on the 3rd inst. after completion The *Mahronda* is intended for Messrs. Brocklebank's Liverpool-Calcutta service. Her dimensions are length over all, 484 ft. 2 in.; breadth, 58ft.; depth 36 ft. 3 in., with a gross tonnage of almost 8,000 tons and deadweight capacity of over 11,000 tons which will make her the largest cargo steamer in the Calcutta trade. The boilers and engines, which are of the direct-acting surface condensing quadruple expansion type, have been designed to give the vessel, when fully loaded, a speed of 12 knots at sea on a moderate consumption of coal. This it is expected, will enable the passage to Calcutta to be made in probably less than twenty-eight days (including the time occupied in passing through the Suez Canal), The propelling machinery have also been constructed by Messrs. Harland and Wolff, in their works at the Abercorn Basin, Belfast. The ship has been built to Lloyd's special survey to Class 100 A1 on the three-deck rule. After adjustment of compasses and a satisfactory trial trip in the Lough, the ship, which is commanded by Captain Niman Bannatyne, proceeded to Liverpool.

BOILER EXPLOSION AT CARDIFF.

THE result of the preliminary inquiry into the explosion from a steam stop valve chest at the Taff Vale Railway Company's hydraulic engine house, East Branch, Cardiff, has just been issued.

The hydraulic power station, where the explosion occurred, is situated at the Docks, Cardiff, and is the property of the Taff Vale Railway Company. The power station is intended to supply hydraulic pressure to the coal tips, elevators, and cranes at the adjacent West Dock, also to a lift at the Queen Street Railway Station, Cardiff. The plant consists of two Lancashire boilers with safety valves loaded to 130 lb. per square inch, two sets of horizontal engines and pumps, also an accumulator. The steam pipes between the boilers and the regulator valve which failed are of steel with welded seams; the main length being of 6-in. internal diameter and the branch piece next to the valve of 5 in. internal diameter. The steam pipes between the regulator valve and the engines are of cast iron.

The engines and connections, including the exploded valve chest, together with the original boilers, were laid down in 1884, and were designed for a working pressure of 130 lb. per square inch, but were worked at 70 lb. only, this pressure subsequently being reduced to 50 lb., solely on account of the age of the boilers. During July of last year, in order to cope with extra elevator and capstan work at the dock, the original boilers, together with the steam pipes up to the regulator valve, were replaced by the present ones.


FRONT VIEW OF REGULATOR VALVE SHOWING FRACTURED COVER

CONDITIONS OF WORKING.

The boilers are seldom worked at a higher pressure than 100 lb., although the safety valves are set to lift at 130 lb. per square inch. Usually, one boiler only is under steam, while the other is being cleaned. It was the practice at the station to keep the main stop valve on the boiler open and a drain cock fitted to each main stop valve chest was also left partly open at all time; this was effected by cutting a small channel round the plug of the cock and leaving its handle in a shut position; water thus drained away continually. A drain cock fitted to the bottom side of the regulator valve chest was usually kept open, but after the explosion was found to be shut; another drain cock on the blank end of the main length of steam pipe was usually left partly open, but on its removal, after the explosion, was found to be nearly choked by sediment deposited in the end of the pipe to which it was attached.

The stop valve was used for regulating the admission of steam to the engines, and the chest which failed was made of cast iron. It had three branches, one inlet and two outlets, all of 5 in. internal diameter. The valve chest cover, also of cast iron, was 1⅛ in. in thickness at the flange, and ⅞ in. in the portion between the flange and the stuffing box. The cover was held in position by six ¾-in. iron studs, having a pitch circle 11⅝ in. in diameter. The valve itself was of brass, of the disc type: a collar on the seat, passing through it, acted as a guide about which it revolved from the open to the closed position. The valve was actuated by a wrought-iron spindle passing through a stuffing box on the cover, the inner end of the spindle being formed to engage with stops on the back of the valve for the purpose of opening or shutting it.

The valve chest cover was fractured where shown by the lines B in illustration. The central part carrying the spindle, together with the bottom part of the cover, was blown away by the force of the explosion, and the two studs marked A.A. were broken off. Steam and water from the boiler escaped, through the opening thus made, into the engine house, until the main stop valve on the boiler was shut. The pressure of the steam at the time of the explosion was stated to be about 70 lb. per square inch.

The explosion is attributed to condensed water which had collected in the main steam pipes, between the controlling butterfly valve and the boilers being set in motion by, and carried forward with the steam, with sufficient force to cause, by its impact thereon, the fracture of the valve chest cover.

The Engineer Surveyor-in-Chief states that the explosion appears to have been the result of water hammer. The engine was doing very little work during the night previous to the explosion, and water apparently accumulated in the main range of steam pipes through one of the drain cocks being kept shut, and the other being almost inoperative through being choked with sedimentary deposit. On the accumulator moving with the demand for water pressure and opening the steam valve to the engines the water of condensation in the pipes was disturbed and set in motion with such force as to burst the stop valve.

TRADE MARKS LAW REFORM.

Closely allied to patent law reform, a question which our readers will remember has received a good deal of attention in Page's Weekly, is the reform of the law relating to Trade Marks. The subject has been under consideration for a considerable time past by a special Committee of the London Chamber of Commerce, and manufacturers have noted with considerable satisfaction that a new and comprehensive measure on the subject has now been passed, which repeals the whole of the existing law as to Trade Marks and substitutes for it a new enactment. The bill on the subject was introduced into the House of Commons by Mr. Fletcher Moulton, K.C., M.P., F.R.S., the well-known patent lawyer, and is one of the most important bills of the year. The bill is an almost unique instance of a private bill, reconstructing as it does the law in a most important branch of commercial legislation, having been permitted by the Government to pass its various stages without opposition.

POINTS OF THE NEW ACT.

The salient features of the new Act, which will come into operation on April 1st next, are pointed out in a communication from T. B. Browne, Ltd. They are a more liberal and less technical definition of "registrable trade marks"; a provision for the registration of trade marks of a particular colour or colours; aa revision of the embarrassing regulations as to "disclaimers"; and increased restrictions upon the non-user of registered trade marks. There is an express enactment that nothing in the new law shall affect the rights of action against any person for "passing-off" goods as those of another person; and attention may be directed to the altered provisions as to the rectification of the Register of Trade Marks, and the option, upon applications for or oppositions to new registrations, of appealing either to the Court or to the Board of Trade. The new measure does not permit the validity of a registration to be attacked after seven years have elapsed, unless it was obtained by fraud.

A POINT OF GREAT IMPORTANCE.

The chief point of interest to trade mark owners is the greater latitude which has been given to the definition of a "registrable trade mark," whereby it is now possible to register many types of trade marks which, though excellent in practice, have hitherto been excluded from registration. The old limitations as to the definition of a "registrable trade mark" operated to prevent the registration of trade marks by British traders in some countries abroad, and, as was stated to the Select Committee of the House of Commons, "English manufacturers and merchants have suffered severely with regard to registration in foreign countries and otherwise." This was chiefly due to the fact that many valuable trade marks could not be registered under the old Act and consequently the proprietors could not register or protect their marks in those foreign countries in which proof of home registration has to be furnished before a mark can be registered. The increased liberty and greater opportunities now to be afforded to trade mark proprietors should go far to redress this grievance.

The changes enacted are not so sweeping as to seriously disturb the existing arrangements of trade mark proprietors, but it will certainly be found that the legislature has provided greater liberty and opportunities in many respects.

MICROSTRUCTURE AND FRICTIONAL CHARACTERISTICS OF BEARING METALS.

By Melvin Price.

THE investigation here recorded was carried out in the laboratories of the department of Mechanical Engineering and the department of Metallurgy at Columbia University. The main questions considered were: (1) The law of variation of the amount of friction with the velocity of sliding, other conditions remaining constant; (2) the theory of Charpy and others regarding the function of the hard grains and of the plastic ground mass in the microstructure of alloys; (3) the theory of Professor Goodman, which received the credence of Professor W. C. Roberts-Austen, the eminent metallurgist, which theory related to the effect produced by elements of high atomic volume as distinguished from the effect of those of low atomic volume in bearing alloys.

Regarding the first of these questions, in the earlier years of the last century, Morin made many observations which he interpreted to mean that the force of friction is independent of velocity. The theory of Charpy evolved through an investigation of the metallurgy of a number of alloys belonging to the types commonly noticed in use in machine practice for bearings was that the friction of hard substances was less than that of soft ones, and that, therefore, the hard grains in alloys supported the load and contributed to the alloy whatever anti-friction quality it possessed, while the plastic ground mass in which the hard crystals were embedded served to allow the bearing step to mould itself around the shaft, producing a better fit.

Goodman's announcement was to the effect that whenever a bearing alloy supposed nominally to contain the ordinary pure metals commonly used for such purposes had added to it a third constituent, the friction was raised or lowered in value according as the added constituent was of low or high atomic volume.

The laws of friction as announced by Morin were as follows:—

The friction between the bodies is directly proportioned to the pressure, *i.e.*, the coefficient is constant for all pressures.

The coefficient and amount of friction, pressure being the same, is independent of the areas in contact.

The coefficient of friction is independent of velocity, although static fritcion (friction of rest) is greater than friction of motion.

LAWS OF FRICTION.

In direct contrast with the above, we find the modern beliefs regarding frictional behaviour stated by Mr. John Goodman in a review of the results obtained from the testing machines of Thurston, Tower, and Stroudley, as follows:—

The coefficient of friction for moderate pressures and speeds varies approximately inversely, as the normal pressure.

The frictional resistance varies as the area in contact, the normal pressure remaining constant.

At very low journal speeds the coefficient of friction is abnormally high; but as the speed of sliding increases from about 10 ft. to 100 ft. per minute the friction diminishes, and again rises when that speed is exceeded, varying approximately as the square root of the speed.

The apparatus by means of which Morin's laws were obtained consisted essentially of a traineau, or sled, whose performance upon a rectilinear track was studied.

Latterly we have seen for the friction test various contrivances, nearly all of which differ radically from the ingenious mode of Morin. Rotative devices are now the most commonly used. In these the moment of the friction is usually measured directly. By means of a rather good machine of the latter type Mr. Beau champ Tower gave to us the results which perhaps form the best basis for a law of friction of which we now have knowledge.

It has been shown that, contrary to the announcement made by M. Morin, the resistance may not always be independent of velocity. We shall now turn to an investigation carried forward for the purpose of finding out whether or not there is a definite law of dependence, such as the one quoted above, or whether the variation appears as characteristic of the given material.

A number of alloys were made and ingots cast into bars of suitable shape, from which sections were cut, polished and examined with the microscope. Suitable half-bearings were then prepared for the testing machine, and from these the frictional retardation curves were obtained. The following method was used for observing the manner in which the friction varied with the speed:—

It occurred to the writer to attempt to measure the force of friction by means of the retardation it produced in the speed of a rotating shaft loaded by having mounted concentrically upon it a heavy disc, when the rotation was subjected to no appreciable retarding or other force except the friction of the two journals at the shaft ends, in simple half (or less) bearing steps. For observing the fall in speed an instrument due to Mr. F. H. Ball, Jun., which may be called the vibrating tachometer, was employed. The latter consists essentially of a long stiff steel bar, fixed at one end, horizontally, and made to tremble by means of an instantaneous contact electro-magnetic arrangement similar to that employed in electric bells. At the free end is attached to the bar, in a vertical plane, a screen containing a narrow horizontal slot. When stationary, this slot just opposes an exactly similar one cut in a stationary screen fixed in the vertical plane, parallel and very near to the screen carried by the vibrating bar. When the movable screen is set vibrating at a sufficiently high frequency, any recurring or cyclic motion observed through the stationary screen will exhibit at successive distinct instants of time the particular phases of its action which are occurring when the vibrating and stationary screens are opposed.

METHOD OF INVESTIGATION.

Two bearing steps were fastened to the sides of a steel frame supported at a convenient height The rotating shaft was ¾ in. in diameter at the middle, and was cut down to ¼ in. in diameter at each end where the steps were fitted. In order to reduce to a minimum the liability of having large apparent areas of contact, but small real ones, these bearing steps were cut to a longitudinal width of about 0·04 in., while their circumferential arc embraced considerably less than half of the ¼-in. journal. The journal was slightly scored to permit only a small amount of axial motion. At the centre of the shaft was mounted a solid brass disc ⅝ in. thick and 5 in. in outside diameter. The weight of the disc and shaft was 4·14 lb. At a short distance away on each side of the disc a journal ½ in. in diameter was cut, which ran in bearings at the end of two arms which were pivoted at a short distance away to the frame of the machine. Attached to these a handle was provided, by means of which the arms could be raised, hooking their ends under the shaft in the journals provided. They thus enabled the observer to raise the rotating system clear of the test bearings into contact with a moving belt, and when at speed to set it down again upon the test bearings and, unhooking the arms, to allow the system to spin freely, except for the friction, when its performance could be observed by the tachometer, suitably arranged a few feet away. The source of power was a small electric motor, provided with a switch for stopping it swiftly at will; a round belt from the motor's pulley travelled over a guide pulley at each end of the frame above mentioned. This belt ran in a horizontal direction an inch or so above the shaft, so that when motion was to be imparted to the rotating mass, it was only necessary to hook the arms under it and raise it clear of the test bearings until a circumferential groove in the shaft engaged with the belt, setting the system into rotation.

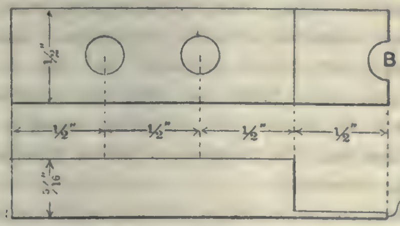


FIG. I.—FORM OF BEARING FOR FRICTION TEST.

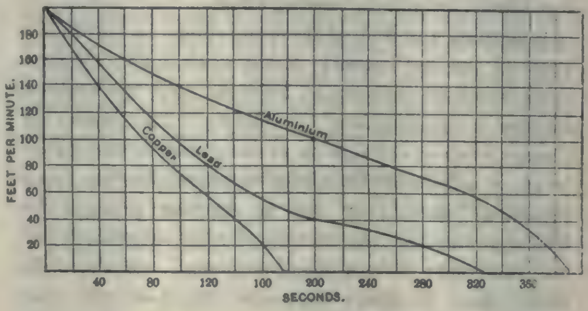


FIG. 2.—CURVES OF PURE METAL.

Alternate quadrants of the brass disc were blackened and the remaining two whitened. Then obviously what may be called a velocity "node" would occur when its speed was such that it made one-half a revolution in the same time in which the screen made one-half oscillation; also when it made a whole revolution per half-oscillation; and also when it went one and one-half revolutions, etc., or nodes would occur at shaft speeds of 1, 2, 3, 4–n times the frequency of oscillation. It was also possible with a little practice to observe the nodes at greater speeds, these being distinguishable from a certain appearance of uniformly gray colour on the disc, apparently stationary, as in the case of the half-nodes. These occurred when the disc revolved one-fourth circumference in the same time that the screen made a half-oscillation.

At first it appeared that since great uncertainty must exist as to the amount of area really in metallic contact in large bearings, it would be well to eliminate as much of this uncertainty as possible by reducing the bearing area. Be it well or ill, it has been assumed that with smaller areas to attend to, very probably the apparent area would represent more nearly the true area in contact. Hence it was decided to work with small areas. In the method adopted the observing apparatus was entirely detached from the system being observed, as was every other disturbing influence, except the atmospheric friction, and whatever vibrations were set up by the spinning system itself.

EXPERIMENTS WITH ALLOYS.

Another part of the work lay in the field of metallurgy. In that connection a number of alloys were made, in which the major number of the different structures which had been noticed might be expected to exist. A number of these were not unlike empirical bearing metals of commerce. These were utilised in the present investigation in the following manner: To a bearing alloy, which usually was very rich in some one of the softer metals, as leaf tin, aluminium, copper, etc., a third constituent would be added in three different proportions. The plan was first to add to the bearing alloy a mere trace of a third metal, which might be supposed to change merely the grouping of the atoms of the other two metals without developing any new crystalline arrangement. Next a somewhat larger quantity of the third constituent was added, which might either develop a new network arrangement of the two excess metals, or develop crystals of a chemical compound with one of these metals. Then a still larger amount of the third constituent was added, which was thought would bring out a larger number of crystals of chemically combined metals, or in some other way change the microstructure. It was hoped in this way to obtain examples of changes effected by the presence of third constituents in bearing alloys which might correspond to changes in the higher orders of asperity upon polished sections.

Specimens of these alloys were cast in an iron mould in the shape of a bar ½ in. by 5-16 in. by 4 in., which was planed to a triangular cross-section and two sides of the prism thus formed were polished and examined under the microscope, before etching, in order to make out so far as possible the harder portions, which they showed in relief.

For the friction test, from a bar like the one whose dimensions are given above, there were shaped two thin sliced bearings of about the dimensions shown in fig. 1, which were bolted to the sides of the frame of the testing apparatus above described, where the bearing surface B supported the journals at the ends of the spinning shaft, and was the test surface. The journal was run in these bearings until it could be seen just which were the contact areas, and these were then taken down slightly with emery cloth and the journals again run upon the bearings, and the process repeated until, so far as could be observed, a perfect fit was attained. Then the retardation curves were taken.

At first it was believed that the true frictional characteristics of the solid materials would be best exhibited in the absence of unguents. But after numerous trials under such conditions, and also under conditions of scanty lubrication, it was decided that at least for the pressures and speeds commonly employed, the amount of abrasion always present made it seem clear that whatever results might be thus obtained would be some kind of an index of rupture, or inner friction, instead of resistance to sliding or outer friction. Accordingly, in the experiments here recorded the bearings were supplied with as much oil (mineral) as would adhere to the journals and to the test bearings after each one or two performances. Such efforts at giving the rubbing members as great an amount of the constant unguent as they would "hold" constitute the whole of the efforts made at uniformity of conditions regarding lubrication.

Difficulty at once appeared when it was desired to interpret the large mass of data obtained. Uniformity of results at first appeared among the impossibles. The friction of the bearings was variable; worse, it was capricious in its behaviour. However, as performances were repeated, great care being taken with cleanliness and uniformity of lubrication, it was noticed that for a given metal the latterly-obtained curves tended towards uniformity of shape, although absolute values of resistance always differed, sometimes only slightly, sometimes considerably. In view of this it was decided that certain performances should be elected from the masses, for each metal which should reflect most nearly the frictional qualities of that metal. In electing these performances at least two qualifications

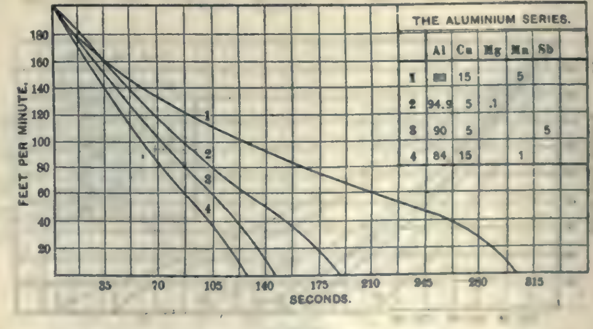


FIG. 3. CURVES OF ALLOYS OF THE ALUMINIUM SERIES.

were recognised as essential: (1) Recognising the fact that probably abrasion caused the majority of the caprices above noticed, and that probably always abrasion increased the resistance; and feeling also a desire to find some basis of comparison of metals as to their absolute resistance, it was decided to elect performances from among the best of each metal, or those showing the lowest resistances. (2) Whenever there appeared a decided but uniform tendency toward some peculiarity in the variation of the resistance, it was decided to select those performances which emphasised these peculiarities most.

The accompanying curves were plotted from the results obtained.

CURVES SHOWING THE VARIATION OF FRICTIONAL RESISTANCE WITH THE SPEED.

Noticing first the curves of the pure metals, it is at once apparent that aluminium, copper and lead have similar speed friction variations in general, but their curves are quite different in detail. Generally, in all three, the resistance is high at high speeds, becoming less as the speed lowers, but rising again near the vanishing point of speed.

The resulting curves for these three metals are not at all similar. A scale factor applied to any one which would make the total running times equal would show the other co-ordinates vastly unequal. This has the effect of impressing us with the fact that the metals have frictional individualities.

In the writer's laboratory at the University of Nebraska, about one year after the above resistance data were taken, the alloys were examined with the microscope. The original ingots, which had been shaped into bearings for the resistance tests, were sectioned, polished with rouge and water upon a wheel faced with baize, etched by a light acid attack, and magnified for examination.

If we are to look for confirmations in the microstructures of any beliefs suggested by frictional performances, we must, of course, neglect the effect of the year's time which elapsed between the tests and the examinations which will now be recorded.

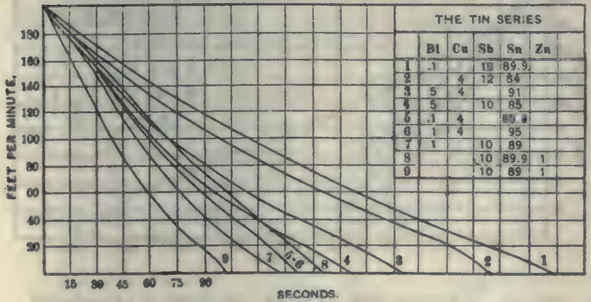


FIG. 4. CURVES OF ALLOYS OF THE TIN SERIES.

Considerable uncertainty exists regarding the chemical combinations of metals. It is widely believed that SbSn exists. Also Cu_3Sn and $SbCu_2$. Indications in the work of Alder Wright have pointed to Bi_3Sb_2 and $CuZn_4$. In the absence of more reliable data, it will be assumed that some such compounds exist but the atomic proportions will be omitted.

It must also be remembered that we are here dealing with ternary alloys. Very great uncertainty exists as to just what happens in a given case when three metals are melted together, and, after being mechanically mixed, allowed to freeze.

In ideas of friction, hardness of the rubbing members comes largely into evidence. And in alloys, where it is expected that totally different physical substances will occur side by side, it is the differences of hardness that we look for largely. The author has by two methods only been able to draw inferences about differences of hardness: (1) By the use of the sclerometer. (2) By observation under the microscope during the operations of polishing the surfaces before etching. The first kind of observation was found useful in the case of the "embedded hard grain" alloys, for it was found easy to detect deviations in the path of the diamond point where it had passed around, or run over without deeply scratching, the hard grains. The second kind of observation was resorted to in a few such cases and generally confirmed the sclerometer tests.

THE TIN SERIES.

The great question is, to what shall we attribute similarities of curves, so that our conclusions may be confirmed by microstructure. Looking at the nine curves, and the nine structures of the tin series, as a whole, all have hard grains embedded in soft matrices. But the curves present many differences in shape. So that hard grains so found are not themselves sole causes of any peculiar resistance variation; also, the size of the grains seems not to determine this resistance variation. Nor does the shape of the grains themselves seem to have the determining effect on the shape of the resistance curve. But let us now notice those constituents which we have not mentioned in discussing the structures, because there seemed no good reason for their appearance as crystals, such as have been mentioned as the features of the microstructures. These may be called the "silent constituents," and are exemplified in the bismuth of a, c, d, e, f and g, and the zinc of h and i, which do not "show up" in the structures. Upon failure to assign reasons, obtainable from structure, for peculiarities of curves, may we attribute the latter to the unseen effect of the "silent constituents"?

CURVES OF BISMUTH ALLOYS.

The remarkable similarity of all curves of alloys containing bismuth and of those containing zinc lend considerable weight to this otherwise purely circumstantial evidence. We may say at this time that we have here part proof, and as yet no reputation, of some such law as the following: The effect of constituents which form hard crystals is constant; the effect of "silent constituents" varies with the speed. The photomicrograph of the alloys whose curves have been entitled "Miscellaneous Alloys," show the structural features of "white metal" and of three yellow alloys of aluminium and copper. In the white metal small squares are visible, and seeing that the composition admits that possibility we may say these are cubes of SbSn. These crystals are comparatively few in number, so that the structure would indicate a resistance performance not very different from that of pure lead. This is seen to be the case when curve 1 of "Miscellaneous" sheet is compared with the curve of lead on the sheet of pure metals. Here is more verification of the belief that crystals of chemically-combined metals embedded in a softer matrix do not affect the manner in which the resistance varies with the speed. A question of great industrial importance is whether or not these crystals greatly affect the actual value of the resistance in the constant manner intimated above in the discussion of the tin series. Comparing the curves of "white metal" and pure Pb, by the scale of times, such belief is confirmed, for the total running time of "white metal" was 252 seconds, while the performance of pure lead was 332 seconds in duration. The effect of the crystals seems to be just what might be expected, i.e., that of increasing the resistance as a whole.

CONCLUSION.

We may now apply the knowledge gained from the study of the resistance curves and the microstructures to the three questions named in the first part of this paper.

(1) A glance at the results shows that a "law" could be made to apply to all of these cases at once only in an extremely general way, if at all. In short, an alloy's resistance performance seems to be peculiar to itself, although there are often partial similarities.

Henceforth our thought may take two or more different channels. It is admitted that generally abrasion is greatest at higher speeds, as we should expect. The upper portions of the curves would generally support an abrasion theory of the variation. There is also support for this in the fact that the softer metals show greater changes of resistance in falling down from the higher speeds. But the latter statement is controverted very largely by comparisons in this detail. Take the pure metals, aluminium, lead and copper: aluminium, which is second in hardness, has very little variation, while copper, first in hardness, has nearly as much of this peculiarity as the very soft lead. As a last argument in support of the influence of abrasion, we may cite the curves of the aluminium-bronzes. These were the hardest of the alloys, and show the least—practically nothing—of variation. So that, for these instances, where there was least abrasion, there was least of higher-speed variation of resistance.

At the lower ends of the curves there are two distinct peculiarities. Fourteen of the twenty curves are decidedly convex upward, and the remaining six just as decidedly straight or convex downward. Abrasion can hardly explain the difference. And the straightness of the other six lends absolutely no support to an abrasion explanation. Also, against such an explanation there may be cited numerous small differences noticed at high speed, between alloys physically very much alike.

On the other hand, it appeared that mechanical imperfections, microscopic structural features, hard crystals of chemical compounds and other "foreign" effects, which make up the lower orders of asperity, had a rather constant influence on the resistance. Also, that groups of alloys could be formed in which peculiarity of performance went hand in hand with one of the three constituents. This constituent was not noticed in the microstructure and was called the "silent constituent." Accordingly it may be inferred that such constituents affect the grouping of the atoms, or even the minute crystals, in such a way as to determine the feature of the higher orders of asperity.

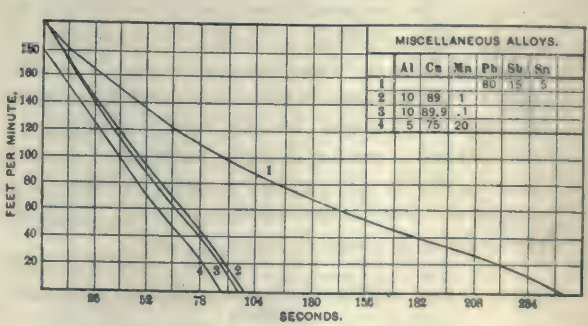


FIG. 5.—CURVES OF MISCELLANEOUS ALLOYS.

On the whole, it does not seem at all improbable to the writer that the lower orders of asperity exert a nearly or quite constant resistance, or that the higher orders exert resistances varying according to the micro-structure, although it may also be true that the variations noticed are resultants of two or more effects, either of which might be constant if taken separately, but that under varying conditions of speed at points more and at other points less of each effect enters into the resultant.

(2) Charpy's conclusions seems to be that it is the hard grains that contribute to the alloy whatever anti-friction quality it possesses. The results of the present investigation seem to the author to work against that conclusion. Notably so in the case of pure lead and the "white metal," which is largely lead, but has the hard cubes of SbSn. It may be well to note the performance of the pure metals, aluminium, copper and lead, in comparison with alloys of those metals. Aluminium ran longer than any of its alloys; and so did lead; likewise copper performed with much less resistance than did any of the yellow alloys of aluminium with copper. The only conclusion which can be come to is that the foreign substances introduced into an alloy as a result of the formation of isolated hard crystals tend to increase the resistance, and as noted in (1) above, in a somewhat constant manner.

(3) The conclusion of Professor Goodman was that if the third constituent of an alloy were a metal of high atomic volume, the resistance was diminished, and if of low atomic volume, it was increased. The observation of the writer that these third constituents when "silent" seem to have a great influence upon the variation of resistance with the speed, leaves the way clear for such a conclusion as Goodman's to obtain; since we may assume that the atomic volume of the elements affects the higher orders of asperity.

In the actual results, look at the curves of the tin series. Comparing 1 and 2, it is seen that in 2 the bismuth of 1 has been replaced by copper. The result is slightly in favour of Goodman's theory, for the atomic volume of Bi is 21·1 and (1) ran 285 seconds, while that of Cu is 7·2 and 2 ran 248 seconds. But the reverse result is obtained when in 6 we replace copper by antimony (atomic volume, 17·9), obtaining 7, which showed greater average resistance. So that these results do not support Goodman's. But it is realised that what is now offered can only be regarded as meagre in its power to refute or confirm.

Abstract of Paper read before the American Institution of Mechanical Engineers.

OPENINGS FOR TRADE ABROAD.

Roumania.

Tenders will be opened on September 28th at the Municipal Offices, Zulcea, for a concession for the construction of an electric lighting system for the town.

Chili.

The British Vice-Consul at Caldera reports that there was a movement last year in the import trade of that port in mining machinery, but the United States of America and Germany had the largest share of the business. This movement, he adds, will be more accentuated this present year.

Belgium.

Tenders, which will be adjudicated on 13th prox, are invited for the construction of a railway between Meirelbeke and Herzele at the estimated cost of about £10,713. A deposit of £1,040 is required to qualify any tender, which should be addressed to M. le Directeur-Général, Société Nationale de Chemins de Fer Vicinaux, 14, Rue de la Science, Brussels. Plans and specifications will be supplied on receipt of one franc.

Russia.

A number of schemes are under consideration for the conversion of some of the existing steam railways to electric working, and the greater part of these schemes are being carried out by German enterprise. The conversion of the Moscow tramway service to electric traction on the overhead system is progressing steadily, although not so rapidly as was anticipated. The improved paving of the streets of Moscow, which is gradually being introduced, encourages the use of motor vehicles.

Spain.

A consular report from Malaga states that the works in connection with two narrow-gauge railways which have been in contemplation for some years, will probably be commenced during 1905. One of these lines will run from Malaga to Torre del Mar and Velez-Malaga (population 23,000), a distance of some 21 miles along the coast to the east, and will find its chief source of revenue in the conveyance of considerable quantities of local produce. The other line, of 20½ miles, for which a concession was granted in March last, will connect with Malaga the important fruit districts, of which Alhaurin el Grande and Coin are the centres. The capital of the company formed to work these lines (Compañía de los Ferro-carriles Suburbanos de Malaga) has been subscribed chiefly in Belgium.

CONTRACTORS' NEWS.

We shall be pleased to insert under this column, free of charge, particulars of open contracts.

CONTRACTS OPEN.

	Last Day.
Rickmansworth—Reconstruction of the Scots Hill Bridge, Rickmansworth, for the Hertfordshire County Council. Mr. Urban A. Smith, county surveyor Hatfield.	Aug. 21
Selby.—Construction, delivery, and erection of duplicate pumping machinery, comprising boilers, triple-expansion engines, surface condensors, force pumps, head gear, and borehole pumps, with a capacity equal to raising 32,000 gallons per hour under a head of 310 ft., for the Selby Urban District Council. Mr. Percy Griffith, M.I.C.E., 54, Parliament-street, Westminster, S.W., and Mr. Bruce Mc Gregor Grey, A.M.I.C.E., Council Offices, Selby, Yorks....	Aug. 28
Motherwell.—Providing (a) two Lancashire steam boilers, 7 ft. diameter by 24 ft. long, and (b) steam and feed pipes, feed pump, feed water heater, feed tank, etc., for the Middle Ward Hospital, Motherwell. Mr. John Dixon, A.M.I.M.E., 219, St. Vincent-street, Glasgow	Aug. 30
Dundalk.—The Dundalk Harbour Commissioners are prepared to entertain applications for supplying a new or second-hand tug, not less than 90 feet long by 18 feet beam; paddle or twin screw; hull of mild steel; if a twin-screw, counters to be well down and broad; one funnel; boiler, mild steel, with pressure of 100 lb.; not less than 60 h.p.; speed not less than 10 knots. Mr. N. Callan, A.M.I.C.E., Harbour Office, Dundalk	Aug. 31
Merthyr Tydfil.—Erection of refuse destructor plant capable of effectually burning 120 tons of refuse per day, together with all buildings and contingent works connected therewith, for the Merthyr Tydfil Urban District Council. Mr. T. Fletcher Harvey, engineer and surveyor to the Council, Town Hall, Merthyr Tydfil	Sept. 1
Wolverhampton.—A vertical triple-expansion pumping engine and other work connected therewith, for the Corporation of Wolverhampton. Mr. E. A. B. Woodward, waterworks engineer, Town Hall, Wolverhampton	Sept. 1
Pontypridd.— Construction of tramway permanent way. Mr. Reginald P. Wilson, 66, Victoria Street, Westminster, S.W. ...	Sept 2
Scarborough.—Construction and erection of a steel bridge over the Scarborough and Whitby railway, of 60 feet span, with masonry abutments and earthwork approaches, at Manor Road, Scarborough, for the North-Eastern Railway Co. Mr. W. J. Cudworth, the company's engineer, at York	Sept. 4
Southampton.—Supplying and fixing at the Corporation Wharf, Chapel, three 18 in. high-pressure direct-acting centrifugal pumping engines, including all suction and delivery pipes, steam and other connections, for the Corporation. Mr. J. A. Crowther, A.M.Inst.C.E., borough engineer, Market Chambers, 123, High Street, Southampton	Sept 4
Neath.—Reconstruction of a bridge over the River Neath and Tennant's Canal, near Neath station, Great Western Railway. G. K. Mills, secretary, Paddington Station	Sept. 5
Bristol.—Construction, delivery, erecting in place, testing, and maintenance for 12 months of pumping machinery for the dry dock now in course of construction at Avonmouth, in the port of Bristol, for the Docks Committee. The contract includes steam engines, centrifugal pumps, steam-boilers, and all auxiliary machinery and piping for the complete installation. Mr. W. W. Squire, Cumberland Road, Bristol.	Sept. 11
Hull.—Construction and erection of the new steel swing-bridge over the River Hull at Sculcoates, on their Victoria Dock branch, and weighing about 450 tons, for the North-Eastern Railway Company. The contract will include the removal of the existing swingbridge, the raising of the public road, and the building of river walls, timber jetty, etc. Mr. W. J. Cudworth, the company's engineer, at York...	Sept. 11
Bishop's Stortford.—The Urban District Council invite tenders for supplying and fixing gas pumping engine, suction gas plant, and sewage pumps at their sewage pumping station. Mr. Thos. Swatheridge, clerk, Council offices, 7, North Street, Bishop's Stortford	Sept. 12
Chelmsford.—The Lighting Committee has been authorised to obtain tenders for lighting the streets and public clock with electricity, gas, or other illuminating power, for three or five years, from March 25th, 1906	—

COMING CONTRACTS

Scarborough.—The Town Council have decided to spend £780 on stone-breaking machinery.

Birkenhead.—The Town Council have decided to obtain powers to enable the erection and completion of the proposed gasworks plant, estimated to cost £50,000, to be proceeded with as soon as possible.

Tavistock.—The Rural District Council have received sanction to a loan of £6,850 for the Horrabridge drainage scheme.

Ashton. — The Guardians have agreed to borrow £5,000 for the purpose of electric lighting.

Rochdale.—A new sewer is to be laid at a cost of £9,000 to £10,000. We understand that the work is to be taken in hand at once. It is proposed to connect the Ramsden reservoir with the present water supply.

CONTRACTS CLOSED.

Southport.—The Lancashire and Yorkshire Railway Company have decided upon making a trial of Roller Bearing axle-boxes made by The Empire Roller Bearings Company on their electrical coaches on the Southport line.

Coventry.—The Daimler Motor Company, of Coventry, have, during the present year, placed orders with Alfred Herbert, Ltd., of Coventry, to the value of over £9,000. This order is principally for turret lathes for finishing cylinders, gear blanks, flywheels, axles and sprocket wheel shafts; and vertical and horizontal milling machines for the equipment of the Daimler Company's new works.

Colchester.—The Corporation have placed an order with R. W. Blackwell and Co. for constructing the permanent way of the Mililtary-road and Old Heath tramway route at £3,936 15s. 9d.

Brighton.—The tender of the Chloride Electrical Storage Company has been accepted by the Council for a 260-cell storage battery for the Southwick power station at £3,600.

Bolton.—The Corporation have accepted the tender of Triumph Stoker, Ltd., of London and Leeds, for two of their mechanical stokers for the new boilers for the electricity works.

Beckenham.—The Council have accepted the tenders of Babcock and Wilcox, boilers, £1,171; General Electric Company, steam alternators (Belliss engine), £1,604; F. and G. Foster, extensions to station buildings, £1,798.

Pudsey.—The A. B. P. Accumulator Company, Ltd., have received orders last week for 58 cells S9 type—21 plates 700 ampere hour battery for Pudsey, Yorkshire.

Barnstaple.—The Barnstaple Town Council have entered into a maintenance contract with the A. B. P. Accumulator Company, Ltd., for maintaining their batteries for five years at £120 per year.

Warrington.—Messrs. N. Greening and Son, Ltd., of Warrington, have instructed Masons Gas Power Co., Ltd., to proceed with the erection of gas producer plant, wire annealing furnace, etc., for their new works at Warrington.

Rishton.—The A. B. P. Accumulator Company, Ltd., have just received orders for 27 cells S2 type—7 plates 210 ampere hour battery for Rishton, Lancashire.

London.—The Islington Council have accepted the tender of Balcke and Co. for the erection of a natural-draught cooling tower in two sections at £1,118, and that of John Spencer, Ltd., for supply of 800 ft. 20 in. diameter steel riveted pipe for circulating mains, with 12 bends of same diameter, for £466 12s.; also the tender of Willans and Robinson for a 1,500-k.w. steam turbo-alternator (Dick, Kerr alternator) exciter, condensing plant, etc., at £8,258.

Southport.—The Town Council have accepted the tender of the Burnand Transformer Company for the supply of 30-k.w. transformers at £50 each.

Darlington.—The Town Council have accepted the tender of Messrs. W. E. Dove and Co., Ltd., of Darlington, for the supply of electric motors for hiring out and hire-purchase.

Wishaw, N.B.—The tender of Callender's Company has been accepted for supplying cables, laying underground mains at Wishaw (N.B.) at £5,437 5s. 3d., that of J. M'Ewan for excavating and reinstating at £677 18s. 4d., and that of Oliver and Co. for 45 arc lamps at £539 10s. 6d.

APPOINTMENTS VACANT.

Llandilo.—The Urban District Council requires a working electrical engineer to take charge of lighting station for one year from 30th September, next. Must be competent to deal with boilers, high-speed engines, mains, accumulators &c. Mr. R. Shipley Lewis, clerk, Llandilo ... Aug. 22

London.—Chief instructor in mathematics in Northampton Institute, St. John's Street Road, E.C. Salary £150 per annum. Particulars of R. Mullineux Walmsley, D.Sc., Principal ... ... Aug. 30

Edinburgh.—Lecturer in electrical engineering in the Heriot-Watt College, Edinburgh. Salary £150 per annum. Applications to P. MacNaughton, Heriot Trust Offices, 20, York Place, Edinburgh. Sept. 3

Derby.—County surveyor for the Derbyshire County Council. £500. Mr. N. J. Hughes-Hallett, clerk... ... ... Sept. 6

APPOINTMENTS FILLED.

Cheltenham.—Mr. W. J. Bache, borough electrical engineer, Gloucester, has been appointed to a similar position under the Corporation of Cheltenham.

Halifax.—Mr. Murdock, assistant to Professor Baily in the Heriot-Watt College, has been appointed head of the electrical engineering department in the Municipal Technical School, Halifax.

West Bromwich.—The Town Council have appointed Mr. W. A. Jackson, borough electrical engineer, at a salary of £300 per annum.

Crewe.—Mr. E. Hancock, of the London and North-Western Railway Company's locomotive and stores department at Crewe, has been appointed stores superintendent of the Ceylon Government Railway, with headquarters at Colombo.

Share List of Engineering, Electrical, Iron and Steel, and other Companies.

The following is a comprehensive list of Companies in the industries covered by "Page's Weekly," in which shares business is being currently transacted. Additions will be made from time to time as occasion requires. We desire it to be understood that while our Share List will generally be found correct, we do not hold ourselves responsible for any loss or inconvenience that may arise from possible inaccuracies.

STOCK EXCHANGE SETTLING DAYS.—Settling days on the Stock Exchange are as follows :—
Consols : Sept. 1st. General Settlements : August 31st, September 14th, 28th. Bank Rate, March 9th, 1905, 2½ per cent

I.—ENGINEERING, IRON, AND STEEL COMPANIES.

Present Amount Subscribed.	Shares.	Last Dividend.	Name.	Paid up.	Closing Prices.
11,370	5	5%	Alldays & Onions Pneumatic Engineering, Ltd.	8	2 — 2¼
10,000	5	3/-	Do. Cum. Pref. 6 per cent. ..	5	4½ — 5
3,210,000	1	1/-	Armstrong (Sir W. G.), Whitworth and Co., Ltd.	1	3¼ — 3⅜
76,970	5	2/-	Do. 4% Cum. Pref.	5	5⅜ — 5⅝
1,500,000	100	4%	Do. 4% 1st Mort. Dbs. Rd.	100	102½—104½
£100,000	100	4½%	Aveling and Porter, Ltd., 4½% Reg. Mt. Debs. Red.	100	96 — 99
5[illegible]0,000	1	2/4⅘	Babcock and Wilcox, Ltd., Ord. ..	1	8½ — 8¾
100,000	1	7⅕d.	Do. „ 6% Cum. Pref.	1	1½ — 1⅝
20,000	5	3/-	Baker (Joseph) and Sons, Ltd., 6% Cum. Pref.	5	4¾ — 5¼
250,000	1	6⅗d.	Baldwins, Ltd., 5½% Cum. Pref. ..	1	1 — 1⅛*
£250,000	Stk	4½%	Do. 1st Mt. 4½% Deb. Stk. Red.	100	102 —104
150,000	4½	2/8⅖	Barrow Hæmatite Steel Co., Ld., O.	4½	1 3/16 — 1 5/16
50,000	4½	3/-	Do. do. Cum 2nd. Pref.	4½	4⅛ — 4⅜
33,334	5	2/6	Bayliss, Jones and Bayliss, Ltd., 5% Cum. Pref. Shares	5	4¾ — 5¼
£500,000	100	4½%	Beardmore (Wm.) & Co., Ltd. 4½% 1st Mt. Debs., Red., Scrip 50% pd	—	103½—105½
50,000	10	6/-	Bell Brothers, Ltd., 6% Cum. Pref.	10	11¾ — 12¼*
£366,600	Stk	4%	Do 4% Deb. Stock, Red.	100	100—102
200,000	1	1/-	Beyer, Peacock and Co., Ltd., Ord.	1	9/32 — 13/32
300,000	1	6⅗d.	Do. 5½% Cum Pref.	1	⅝ — ¾
£300,000	Stk	4½%	Do. 4½% Red. Deb. Stock	100	94 —97
1,629,760	1	6d.	Bolckow, Vaughan and Co., Ltd., O. Nos. 1-1,629,760	1	15/16 — 1
1,860,900	1	3⅗d.	Do. Nos. 1,639,101-3,500,000	12/-	½ — 9/16
1,160,000	1	10⅕d.	Brown (John) and Co., Lim., Ord., Nos. 1-1,160,000	15/-	1 3/16 — 1 5/16
590,000	1	1/2	Do. Ord., Nos. 1,160,001-1,750,000	1	1⅝ — 1¾
74,000	10	5/-	Do. 5 % Cum. Pref.	10	11⅛—11⅜
154,500	5	5/-	Cammell, Laird & Co., Ltd., Ord. ..	5	8⅞ — 9⅛
232,500	5	2/6	Do. 5% Cum. Pref. ..	5	5½ — 5¾
450,000	1	1/2⅖	Clayton & Shuttleworth, Ltd., Ord.	1	15/16 — 1
70,000	5	2/6	Do. 5% Cum. Pref.	5	5¼ — 5½
£250,000	Stk	4%	Do 4% 1st Mort. Db. Stk. Red	100	100 -102
100,000	10	7/6	Consett Iron Co., Ltd., Ord.. ..	7½	32½ — 33½
57 031	'10	10/-	Crossley, Bros., Ld., Ord. 40340/97370	10	15⅝—16
40,339	10	5%	Do. 5% Cum. Pref.	10	11¾—11⅞
75,000	1	2/6	Delta Metal, Ltd. Shares	1	2⅛ — 2⅜
1,259,594	1	3⅗d.	Dorman, Long & Co., Ltd.	1	17/32 — 19/32
£400,000	Stk	4%	Do. 4% 1st Mort. Perp. Deb. Stk.	100	88 —92
200,000	5	3/-	Dunderland Iron Ore Co., Ltd., 6% Cum. Pref. and Participating..	5	3 — 3½
250,000	1	9⅗d.	Dunlop (James) & Co., Ltd., Ord...	1	9/16 — 11/16
300,000	1	7⅕d.	Do. 6% Cum. Pref. ..	1	13/16 - 15/16
4,721	13	13/-	Ebbw Vale Steel, Iron & Coal Co., Ltd.	13	8½ — 9½
69,754	13	10/-	Do. do. do.	10	6½ — 7
20,250	10	8/-	Elliott's Metal, Ltd.	8	5¼ — 5¾
5,000	10	5%	Do. Cum. Pref. 5%	10	8¾ — 9¼
186,748	Stk	4%	Do. Deb. 4%	100	90 — 94
25,000	10	6/-	Fairfield Shipbuilding & Engng. Co., Ltd., 6% Cum. Pref. ..	10	11 — 11½
£250,000	Stk	4½%	Do. 4½% Mort. Deb. Stk. Red.	100	100 —103
9,000	10	10%	Fleming & Ferguson, Ltd. Ord. Nos. 1/9000..	10⅛	12¼—12½
6,000	10	5%	Do. 5% Cum. Pref. Nos. 9001/15000	10	9½—10⅕
126,000	3	3/-	Fraser & Chalmers, Ltd., Ord. ..	3	3¾—4¼
21,000	3	1/6	Do. 7½% Cum. Pref.	3	5½ — 6
10,000	10	5%	Galloways, Ltd., 5% Cum. Pref. 18001/28000	10	6 — 7
£150,000	Stk	4%	Do. 4% 1st Mort. Deb Red..	100	88½—89½
16,800	10	10/-	Greenwood & Batley, Ltd., Ord. ..	10	7 — 7¼
9,600	10	7%	Do. 7% Cum. Pref.	10	10 — 10½
965,000	1	1/-	Guest, Keen & Nettlefolds, Ltd. Ord.	1	2 5/16 — 2 7/16
344,000	5	2/6	Do. 5% Cum. Pref.	5	6¼ — 6½
£1,850,500	Stk	4%	Do. 4% Irred. Mort. Deb. Stk	100	105 —107
13,000	5	2/6	Gwynnes, Ltd., 5% Cum. Pref. ..	5	2 — 3
250,000	1	3/6	Hadfield's Steel F'dry Co., Ld., Ord.	1	3 7/16 — 3 9/16
20,000	10	4/6	Do. 4½% Cum. Pref.	10	10½ — 11
30,000	5	3/-	Hall (J. & E.), Ltd. 6% Cum. Pref...	5	5 — 5½*
408,505	1	1/6	Harvey United Steel Co., Ltd. ..	1	1 3/16—1 5/16*
47,500	10	7½%	Hawthorn, Leslie & Co., Ltd. Ord.	10	97— 99
28,001	5	7/-	Head, Wrightson & Co., Ltd. ..	5	4¾ — 5¼
85,000	1	7⅕d.	Hill (Richard) & Co. (1899) Ld., Ord.	1	¾ — ⅞
18,000	5	3/-	Do. 6% Cum. Pref.	5	4⅞ — ⅝
£100,000	Stk	6 %	Hornsby (Richard) & Sons, Ld., Ord. 6% Cum. Pref.	100	98—100

ENGINEERING, IRON, AND STEEL COMPANIES.—*Contd.*

Present Amount Subscribed.	Shares.	Last Dividend.	Name.	Paid up.	Closing Prices.
750,000	1	7½%	Howard & Bullough, Ltd., Ord. ..	1	1 7/16 — 1 9/16
25,000	10	6/-	Do. 6% Pref. (Non-Cum.) ..	10	12¾—13¼
£250,000	Stk	4%	Do. 4% Deb. Stk., Red. after 1905	100	95 —98
37,500	10	20	Kynoch, Ltd.	10	17 —17½
49,537	10	5%	Do. Cum. Pref. 5%	10	10½—10¾
300,000	1	4⅕d.	Lambert Bros., Ltd., Ord.	1	⅜ — ⅝
50,000	5	2/9	Do. 5½% Cum. Pref.	5	4 — 4½
40,000	8	2/1⅗	Leeds Forge Co., 7% Cum. Pref. ..	8	3½ — 4
200,000	1	7⅕d.	Lysaght (John), Ltd., 6% Cum. Pf.	1	1 5/16 — 1 7/16
£300,000	Stk	4½%	Do 4½% 1st Mt. Deb. Stk., Red.	100	108 —110
40,000	10	5/-	Mather & Platt, Ld., 5% Cum. Pref	10	11½—12
210,000	1	8⅖d.	Measures Bros., Ltd., Ord.	1	½ — ¾
75,000	1	6⅗d.	Do. 5½% Cum. Pref.	1	¾ — ⅞
£75,000	Stk	4½%	Do. 4½% 1st Mrt. Db. Stk., Red.	100	92 — 95
21,943	5	2/6	Muntz Metal, Ltd.	5	4½ — 5
14,248	5	5%	Do. Pref. 5%	5	4⅞ — 5⅛
5,000	62½	47/6	Nantyglo and Blaina Iron Works, Ltd., 8% Cum. Pref.	62½	79 — 81
73,000	10	5/-	N. Brit. Loco. Co., Ltd., 5% Cm. Pf.	10	12⅛—12¼
80,000	5	—	North-Eastern Steel Co., Ltd.,		
£250,000	Stk	4½%	4½% 1st Mrt. Db. Stk., Red.	100	88 — 91
122,000	5	1/6	Pearson & Knowles Coal and Iron Co., Ltd., Ord., "B"	5	3½ — 3¾
50,000	5	8/-	Do. 6% Cum. Pref. "A" ..	5	6¼ — 6¾
70,000	10	6/-	Pease & Partners, Ltd., Ord. ..	10	9¾—10¼
£400,000	Stk	4%	Do. 4% Perp. Deb. Stock ..	100	99 —102
20,000	5	8/-	Peebles (Bruce) & Co., Ld., 6% Cm. P.	5	5 — 5¼
65,000	1	—	Pooley (Henry) & Son., Ltd., Ord ..	1	6/6 — 7/-
13,000	5	—	Do. 5½% Cum. Pref.	5	4 — 4½
230,000	1	—	Projectile Co. (1902), Ltd., Ord. ..	1	⅜ — ½
126,938	5	2/-	Rhymney Iron Co., Ltd.	5	1½ — 1¾*
73,062	5	2/-	Do. New	5	1⅜ — 1⅝*
£330,000	—	5%	Do. 5% Mort. Deb., Red. ..	100	99—101
350,000	1	7⅕d.	Richardsons, Westgarth & Co., Ltd., Ord. 350,001—700,000 ..	1	27/32 — 29/32
£350,000	1	7⅕	Do. 6% Cum. Pref.	1	⅞ — 1
£350,000	Stk	4½%	Do. 4½% Perp. Deb. Stock ..	100	94 — 97
35,000	10	12/-	Ruston, Proctor & Co., Ltd... ..	10	10 —10½
275.000	1	6d.	Scott (Walter) Ltd., Ord.	1	11/16 — 13/16
300,000	1	7⅕d.	Do. 6% Cum. Pref. ..	1	⅞ — 1
£300,000	Stk	4%	Do. 4% Perp. Deb. Stk.	100	93 — 95
£115,300	100	5%	Shelton Iron, Steel and Coal Co., Ld. 1st Charge 5% Debs.. Red ..	100	92 — 95
£97,900	100	6%	Do. 6% 2nd Mort. Debs., Red.	100	94 — 98
250,000	1	1/-	South Durham Steel & Iron, Ltd. Or.	1	11/16 — 13/16
300,000	1	1/2⅖	Do. 6% Cum. Pref...	1	¾ — ⅞
£300,000	Stk	4½%	Do. 4½% Per. Deb. Stock	100	91 — 94
49,560	10	2½%	Steel Co. of Scotland Ord. 1/49560..	9	5¾—6¼
£125,240	Stk.	5%	Do. 5% Trust Mort. Deb. ..	100	105—106
25,000	10	—	Stephenson (Robert) & Co., Ltd., Or.	10	2 — 2¼
25,000	10	5/6	Do. 5½% Cum. Pref. ..	10	3⅞ — 4⅛
£250,000	Stk	4%	Do. 4% Perp. Deb. Stock	100	80— 85
85,000	10	9/-	Stewarts & Lloyds, Ltd., Ord. ..	10	17¾—18¼
55,000	10	6/-	Do. 6% Cum. Pref.	10	14½ — 15
684,732	1	6d.	Swan, Hunter & Wigham-Richardson, Lim. Ord.	1	13/16 — 15/16
538,845	1	6d.	Do. 5% Cum. Pref.	1	15/16 — 1 1/16
£240,000	Stk	4½%	Do. 4½% 1st Mort. Deb. Stk. Red	100	96 — 99
300,000	1	6d.	Thames Iron Works, Shipbuilding & Engineering Co., Ltd., 5% Cum. Pf.	1	⅝ — ¾
£200,000	100	4%	Do. 4% Irredeem. 1st Mort. Deb.	100	79 — 83
£148,500	1	7⅕d.	Thornycroft (John I.) & Co., Ltd. Or.	1	⅝ — ⅞
£160,000	1	7⅕d.	Do. do. 6% Cum. Pref.	1	15/16 — 1 1/16
10,000	10	5/-	Tylor (J.) & Sons, Ltd. 5% Cum. Pf.	10	9½ — 9¾
$508495200	$100	$½	United States Steel Corp. Com. Stk.	$100	37¼ — 37¾
$360314100	$100	$1¾	Do. 7% Cum. Pref. Stock	$100	109¼—109¾
$162268000	$1000	5%	Do. 10-60yr. 5% Skg. Fd. G. Bds.	$1000	100— 102
3,350,000	1	1/-	Vickers, Sons & Maxim, Ltd. Ord..	1	2⅜—2½*
750,000	1	6d.	Do. 5% Non-Cum. Pref. ..	1	1 3/16 — 1 5/16*
£750,000	Stk	5%	Do. 5% Non-Cum. Pref. Stock.	100	120 —123
£1,250,000	Stk	4%	Do. 4% 1st. Mort. Deb. Stk. Red.	100	104 —106
£1,000,000	100	4½%	Do. 4½% 2nd Mort. Debs., Red.	100	106 —108
225,000	1	1/2⅖	Weardale Steel, Coal & Coke, Ltd., Def. Ord.	1	13/16 — 15/16
500,000	1	7⅕d.	Do. 6% Cum. Pref. Ord. ..	1	⅞ — 1
£300,000	Stk	4%	Do. 4% Perpetual Deb. Stock	100	85 — 88
7,637	5	2/9	Weldless Steel Tube, Ltd., Cum. Pref. 5½	5	4½ — 4¾
300	Stk	4½%	Do. Mort. Deb. 4½%	100	92 — 98
66,666	5	3/.	Willans & Robinson, Ord.	5	1 — 2
66,666	5	3/-	Do. 6% Cum. Pref.	5	2½ — 3½
£246,641	Stk	4%	Do. 4% 1st Mort. Deb. Stk. Red	100	73 — 78
£150,000	Stk	4½%	Yorkshire Iron & Coal Co., Ltd., 4½% 1st Mort. Deb. Stk. Red.	100	74 —76

Stocks and Shares marked * are quoted ex-dividend.

ELECTRIC LIGHTING AND POWER.—*Contd.*

Present Amount Subscribed.	Shares.	Last Dividend.	Name.	Paid up.	Closing Prices.
£135,000	Stk	4%	Kensington and Knightsbridge Electric Lighting Co., Ltd., and the Notting Hill Electric Lighting Co., Ltd., 4% Deb. Stock, Red.	100	102 —104
111,000	3	1/9⅗	London Elec. Supply Corp., Ld., Ord.	3	2 — 2½
60,000	5	3/-	Do. 6% Pref.	5	5 — 5½
£371,895	Stk	4%	Do. 4% 1st Mort. Db. Stk., Red.	100	99 -102
100,000	10	11/-	Metropolitan Elec. Sup. Co., Ld., Or.	10	9¾ —10¼
76,121	5	2/3	Do. 4½% Cum. Pref.	5	5½ — 5¾
220,000	Stk	4½%	Do. 4½% 1st Mort. Db. Sk., Red.	100	109 —113
250,000	Stk	3½%	Do. 3½% Mort. Deb. Stk, Red.	100	98 —100
£250,000	—	4½%	Midland Elec. Corp. for Power Distribution, Ld., 4½% 1st Mort. Deb.	100	99—101%
10,852	10	8/-	Notting Hill Elec. Ltg. Co. Ltd. Ord.	10	14 — 15
£59,000	100	4%	Do. 4% 1st Mort. Debs. ..	100	100 —102
16,500	5	4/6	Oxford Electric Co. Ltd., Ord. ..	5	6½ — 7
£50,000	Stk	4%	Do. 4% Debenture Stk. Red.	100	98 —100
£84,700	100	4½%	Royal Elec. Co. (of Montreal) 4½% 20-yr. 1st Mort. Deb	100	101 —104
40,000	5	5/-	St. James' & Pall Mall Elec. Light Co., Ltd. Ord.	5	13½—14½*
20,000	5	3/6	Do. 7% Pref.	5	8½ — 9*
£150,000	Stk	3½%	Do. 3½% Deben. Stock, Red	100	97 —99
12,000	5	4/-	Smithfield Markets Elec. Supply Co., Ltd. Ord.	5	2⅝ — 2⅞
£50,000	Stk	4%	Do. 4% Debenture Stk. Red.	100	76 — 80*
65,000	5	4/-	South London Elec. Sup. Co., Ltd. O.	5	3½ — 4
100,000	1	—	South Metropolitan Elec Light & Power Co., Ltd. Ord.	1	13/16 — 15/16
50,000	1	8⅗d.	Do. 7% Cum. Pref.	1	15/16 —1 7/16
£100,000	Stk	4½%	Do. 4½% 1st Deb. Stock Red.	100	106 —109
50,000	5	2/6	Urban Electric Supply Co., Ltd., O.	5	4⅛ — 4⅞
30,000	5	2/6	Do. 5% Cum Pref.	5*	5⅛ — 5⅜
£200,000	Stk	4½%	Do. 4½% 1st Mort. Deb. Stk. Red	100	105—107
110,000	5	6/6	Westminster Elec. Supply Corp. Ltd., Ord.	5	12¼—13*
28,151	5	2/6	Do. 5% Cum. Pref.	5	6⅛ —6⅝

V.—TELEGRAPH & TELEPHONE COMPANIES.

Present Amount Subscribed.	Shares.	Last Dividend.	Name.	Paid up.	Closing Prices.
£34,800	100	4%	African Direct Tel. Co., Ld., 4% Mt. Debs. (Series A), Red.	100	99 —102
25,000	10	—	Amazon Telegraph Co., Ld... ..	10	3½ — 4
£763,580	Stk	14/-	Anglo-American Tel. Co., Ltd., Ord.	100	59 — 61*
£3,118,210	Stk	28/-	Do. 6% Preferred Ordinary	100	106 —107*
£3,118,210	Stk	2/-	Do. Deferred Ordinary ..	100	14½ — 14¾
44,000	5	5/-	Chili Telephone Co., Ltd.	5	7⅛ — 7⅜*
$15,000,000	$100	$8	Commercial Cable Co., Capital Stk.	$100	———
£1,903,856	Stk	4%	Do. Sterl. 500-yr 4% Deb. Stk., Red.	100	96½—98½
16,000	10	5/-	Cuba Submarine Tel. Co., Ld., Ord.	10	8¾ — 9¼
6,000	10	10/-	Do. 10% Preference	10	17 — 18
6,000	5	2/-	Direct Spanish Telegraph Co., Ord.	5	3⅜ — 3⅝
		5/-	10% Cum. Preference	5	9 — 9½
£30,000	50	4½%	Do. 4½% Debs...	50	100-103%
60,710	20	4/-	Direct U.S. Cable Co., Ltd... ..	20	11½—11¾*
£85,800	100	4½%	Direct West India Cable Co., Ltd., 4½% Reg. Debs.	100	100—102
£300,000	100	4%	East. & S. African, Ld., 4% Mt. Dbs.	100	99—101*
£200,000	25	4%	Do. 4% Rg. Mt. Dbs. (Mauritius Subsidy)..	25	101—103%
900,000	10	2/6	Eastern Extension, Australasia and China, Ltd...	10	13¾—14¼
£602,400	Stk	4%	Do. 4% Mort. Deb. Stk., Perp.	100	105-107*
£4,000,000	Stk	25/-	Eastern Tele. Co., Ltd., Ord. ..	100	142 —145
£2,000,000	Stk	17/6	Do. 3 % Pref.	100	30 —92*
£1,836,814	Stk	4%	Do. 4% Mort. Deb.	100	107 —109
150,000	10	5/-	Great Northern Telegraph Co., Ltd., (of Copenhagen) ..	10	35 —36
£58.700	100	4½%	Halifax and Bermudas Cable Co., Ltd., 4½% 1st. Mort. Debs. Red.	100	99—101
17,000	25	12/6	Indo-European Tele. Co., Ltd. ..	25	51½— 53½
72.680	1	7⅕d.	Monte Video Telephone Co., Ltd., O.	1	¾ — ⅞
£1,983,333	Stk	6%	National Telephone Co., Ltd., Pref.	100	109—110*
£1,966 667	Stk	5%	Do. Deferred	100	106 —108*
250,000	5	2/6	Do. 5% Non-Cum. 3rd Pref.	5	5⅝ — 5⅞*
£2,000,000	Stk	3½%	Do. 3½% Deb. Stk., Red. ..	100	99 —101
£689,593	Stk	4%	Do. 4% do. do. ..	100	103—105
179,313	1	8⅘d.	Oriental Telephone & Elec. Co., Ltd.	1	1 3/16 — 1 5/16
50,000	1	7⅕d.	Do. 6% Cum. Pref.	1	1⅛—1¼
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. Red...	100	98 —101
11,889	8	4/-	Reuter's Telegram Co., Ltd. ..	8	7½— 8
58,000	5	3/-	United River Plate Telep. Co., Ltd.	5	6¾ - 7¼
40,000	5	2/6	Do. 5% Cum. Pref.	5	5⅛— 5⅜
£179,947	Stk	5%	Do. 5% Deb. Stock, Red. ..	100	108—110
15,609	10	5/-	W. African Telegraph Co., Ltd. ..	10	8¾ —9¼
£30,008	2½	—	West Coast of America, Ltd. ..	2½	½ — ⅝
150,000	100	4%	Do. 4% Deb. Guar. by West. Tel.	100	100—102

TELEGRAPHS AND TELEPHONES.—*Contd.*

Present Amount Subscribed.	Shares.	Last Dividend.	Name	Paid up.	Closing Prices.
88,321	10	6d.	W. India & Panama Teleg. Co., Ld., Or.	10	9/16 —11/16
34,563	10	6/-	Do. 6% Cum. 1st. Pref. ..	10	8 — 8½
4,669	10	6/-	Do. 6% Cum. 2nd Pref. ..	10	5¾ — 6¼
£80,000	100	5%	Do. 5% Deb.	100	100 —103
207,930	10	3/-	Western Telegraph Co., Ltd. ..	10	13¾—14¼
£75,000	100	5%	Do. 5% Debs., 2nd Series, 1906	100	100 —102
518,945	Stk	4%	Do. 4% Deb. Stock, Red. ..	100	102 —104

VI.—SHIPPING COMPANIES.

Present Amount Subscribed.	Shares.	Last Dividend.	Name.	Paid up.	Closing Prices
32,500	10	5/6	Anchor Line (Henderson Bros.), Ltd., 5½% Cum. Pref.	10	8¾ — 9¼
£325,000	Stk	4½%	Do. 4½% Red. 1st Mort. Deb. Stk.	100	100—102
£672,900	Stk	4½%	British & African Stm. Nav. (1900) Ltd., 4½% 1st Mort. Deb. Stk., Red.	100	95 — 97
40,000	10	5/6	Bucknall Steamship Lines, Ltd., 5½% Cum. Pref.	10	5¾ — 6¼
£600,000	Stk	4½%	Do. 4½% 1st Mort. Deb. Stk.	100	87 — 91
£750,000	Stk	4½%	Clan Line Steamers, Ltd., 4½% Deb. Stk. Red. ..	100	99 —101
60,000	20	16/-	Cunard Steam Ship Co., Ltd., Nos. 1-60,000..	20	11¾ — 12¼
40,000	20	8/-	Do. Nos. 60,001-100,000	10	4¾ — 5¼
£464,430	Stk	4½%	Elder Dempster Shipping, Ltd., 4½% 1st Mort. Deb. Stk. ..	100	102—104
1,200,000	1	6d.	Furness, Withy & Co., Ltd., Ord...	1	1¼ — 1½
25,328	7½	4/7	Gen. Steam Navigation Co., Ld., Ord.	7½	5 — 5½
36,758	8	4/9⅗	Do. Non-Cum. 6% Pref... ..	8	7¾ — 8¼
£150,000	Stk	4%	Do. 4% 1st Mort. Deb. Stk. Red.	100	98 —100
55,000	5	1/3	Houlder Line, Ltd., Ord.	5	2¼ — 2¾
40,000	5	2/9	Do. 5½% Cum. Pref.	5	2¾ — 3¼
£200,000	Stk	4½%	Do. 4½% 1st Mt. Deb. Stk. Red.	100	86 — 88
141,500	10	5/-	Leyland (Fredk.), & Co.. (1900), Ltd., 5% Cum. Pref. ..	10	4 — 4½
£1,160,000	Stk	5 %	Peninsular and Oriental Steam Nav. Co., 5% Cum. Pref. ..	100	129 —132
£1,160,000	Stk	19%	Do. do. Deferred ..	100	225 —228
15,000	100	30/-	Royal Mail Steam Packet Co. Ord..	60	35 — 36
39,075	5	2/6	Shaw, Savill & Albion, Ltd., 5% Cum. "A" Pref..	5	4¾ — 5¼
39,075	5	2/6	Do. "B" Ord...	5	4 — 4½
141,841	10	4/-	Union Castle Mail Steamship Co., Ltd., Ord..	10	8½ — 9
24,000	10	4/6	Do. 4½% Cum. Pref... ..	10	10¼ — 10¾
£1,008,894	Stk	4%	Do. 4% Debenture Stk., Red.	100	100 —102

VII.—MISCELLANEOUS COMPANIES.

Present Amount Subscribed.	Shares.	Last Dividend.	Name.	Paid up.	Closing Prices.
60,000	1	9⅗d.	Chadburn's (Ship) Tele. Ltd., Ord...	1	1⅛ —1¼
£750,000	Stk	9%	General Hydraulic Power Co., Ltd.	100	126 —131
12,500	10	10/-	Oakey (John) and Sons, Ltd., Ord..	10	24 — 26
10,000	10	6/-	Do. do. 6% Cum. Pf.	10	14 — 15
183,538	1	6·3d.	Power Gas Corp., Ltd., Ord., Nos. 66,463-250	15/-	¼ — ⅜
66,462	1	8·4d.	Do. do. Nos. 1 66,462	1	⅜ — ½
135,000	1	6d.	Waygood (R.) & Co., Ltd., Ord. ..	1	1 1/16 —1 3/16
135,000	1	7⅕d.	Do. 6% Cum. Pref. ...	1	1 1/16 —1 3/16

RAILWAY CARRIAGE & WAGON COMPANIES.

Present Amount Subscribed.	Shares.	Last Dividend.	Name.	Paid up.	Closing Prices.
10,000	10	7/6	Birm. Railway-Car. & Wagon, L., 1-10,000	10	22¾—23¼
8,739	10	3/-	Do. Second Issue 1-8,739....	4	8⅞ — 9¼
10,000	10	6/-	Do. Cum. Pref. 6% 1-10,000..	10	13¾—14
30,111	7	7/-	Gloucester Rail.-Car & Wagon, Ld., A, 1-29,861 & 49,751-50,000	7	9¾ — 10
44,889	7	3/6	Do. B, 29,862-49,750, 50,001-75,000	7	4* — 4½
14,567	10	1/3	Lancashire Wagon, Ord.	2	2⅛ — 2⅜
4,150	10	5%	Do. do.	10	10½ — 10¾
784,808	1	9d.	Metropolitan Amalgamated Rail.-Carriage & Wagon, Ld., 1-784,808	1	43/ 43/6
164,288	1	6d.	Do. Cum. A Pref. 5% 1-164,288	1	23/9--24/3
235,000	1	7⅕d.	Do. Cum. B Pref. 6% 1-235,000	1	28/6--29/6
20,000	20	20/-	Midland Rail.-Car. & Wagon, Ld., 1-20,000	10	19 —19½

Stocks and Shares marked * are quoted ex-dividend.

II.—ELECTRICAL MANUFACTURING COMPANIES.

Present Amount Subscribed.	Shares.	Last Dividend.	Name	Paid up.	Closing Prices.
70,000	1	6d.	Alliance Elec. Co., Ltd. 5% Cum. Pf.	1	⅜ — ⅞
125,000	1	7½d.	Aron Elec. Meter Ltd., 6% Cum. Pf.	1	7/16 — 9/16
120,000	1	1/2⅗	Bell's Asbestos Co., Ltd.	1	1 1/16 — 1 3/16
100,000	5	4/-	British Insulated & Helsby Cables Ltd., Ord. ..	5	5½ — 6
100,000	5	3/-	Do. 6% Cum. Pref.	5	5½ — 6*
£500,000	Stk	4½%	Do. 4½% 1st Mort. Deb. Stk. Rd.	100	101 —104
£200,000	Stk	4½%	British Thomson-Houston Co., Ltd., 4½% 1st Mort. Deb. Stk. Red. ..	100	100—102
400,000	5	3/-	British Westinghouse Electric and Manufac. Co., Ltd., 6% Pref. ..	5	2⅜ — 2⅝
£616,353	Stk	4%	Do. 4% Mort. Deb. Stk. Red...	100	85 — 89
105,731	2	2/-	Brush Elec. Enging. Co., Ltd., Ord. .	2	½ — ¾
150,000	2	2/4⅘	Do. 6% Pref.	2	1¼ — 1¾
£125,000	Stk	4½%	Do. 4½% Perp. 1st Deb. Stk...	100	92 — 95
£125,000	Stk	4½%	Do. 4½% Perp. 2nd Deb. Stk.	100	78 — 81
35,000	5	7/6	Callender's Cable & Constn. Ltd. Ord.	5	10 — 11
40,000	5	2/6	Do. 5 % Cum. Pref.	5	5½ — 5¾
£200,000	Stk	4½%	Do. 4½% 1st Mort. Deb. Stk. Red.	100	107 —109
85,000	3	1/6	Crompton & Co., Ltd...	3	1½ — 2*
£100,000	—	5%	Do. 5% 1st Mort. Reg. Debs.	100	94—99%
52,000	5	10/-	Dick, Kerr & Co., Ltd., Ord. ..	5	7¾ — 8¼
61,000	5	3/-	Do. 6% Cum. Pref.	5	6 — 6½
£300 000	Stk	4½%	Do. 4½% Deb. Stock, Red. ..	100	105 —107
233,334	1	6d.	Doulton & Co., Ltd., 5% Cum. Pref.	1	1½ — 1⅝
£233,334	Stk	4%	Do. 1st Mort. 4% Iree. Deb. Stk.	100	106 —109
99,261	5	1/6	Edison and Swan United Electric Light, Ltd., "A" Shares Nos. 1-99,261	3	1⅛ — 1⅜
17,139	5	2/6	Do. "A" Shares Nos. 01-017,139	5	2 — 2½
£344,023	Stk	4%	Do. 4% Deb. Stock Red. ..	100	83 — 88
£100,000	Stk	5%	Do. 5% Second Deb. Stk. Red.	100	89 — 94
112,100	2	1/7⅕	Electric Construction Co., Ltd. ..	2	⅜ — ⅝
31,390	2	2/9⅗	Do. 7% Cumulative Pref. ..	2	1¾ — 2¼*
£200,000	Stk	4%	Do. 4% Perp. 1st Mt. Deb. Stk.	100	93 — 96
10,248	10	7/6	Evered and Co., Ltd...	10	10 — 12
£100,000	Stk	5%	Ferranti, Ltd., 5% 1st Mort. Deb. Stock, Red...	100	90 — 95
25,000	10	5/-	Gen. Elect. Co. (1900), Ltd., 5% Cum. Pref.	10	9½ — 10
£200,000	Stk	4%	Do. 4% 1st. Mt. Deb. Stk., Red.	100	97—101
35,000	5	10/-	Henley's (W. T.) Telegraph Works Co., Ltd., Ord.	5	11½—12½
35,000	5	2/3	Do. 4½% Cum. Pref.	5	5⅜ — 5⅝
£50 000	Stk	4½%	Do. 4½% Mt. Deb. Stk. Red.	100	109—111
50,000	10	5/-	India Rubber, Gutta Percha & Telegraph Works Co., Ltd.,	10	15 — 16
£300,000	100	4%	Do. 1st Mort. Deb. Red. ..	100	100 —103
7,500	10	—	Parker, Thos., Ltd.	10	6½ — 7
100,000	1	3%	Scott (Ernest) & Mountain, Ld., Ord.	1	16/3—16/9
37,350	12	12/-	Telegraph Construction and Maintenance Co., Ltd.	12	31½ — 32½
£150,000	100	4%	Do. 4% Deb. Bonds	100	102—104

III.—ELECTRIC TRACTION.

Present Amount Subscribed	Shares.	Last Dividend.	Name.	Paid up.	Closing Prices.
120,000	5	5/-	Anglo-Argentine Trams Co., Ld., Or.	5	8⅜ — 8⅝
260,007	5	2/6	Do. 5% Cum Pf.	5	5¾ — 6
£230,000	Stk	6%	Do. Permanent 6% Debenture Stock, 1888 ..	100	141 —144
20,000	10	12/-	Barcelona Trams Co., Ltd., Ord. ..	10	13¾ — 14¼
10,000	10	5/-	Do. 5% Cum Pf. Shares	10	9½ — 10¼
£46,800	100	5%	Do. 5% Debs., Red. ..	100	98 —101
£191,326	Stk	4½%	Do. 4½% Red. Deb. Stk.	100	97 —102*
75,606	1	—	Bath Elec. Trams. Ld., Pf. Or. ..	1	13/16 — 15/16*
59,394	1	11·1d	Do. 5% Cum. Pf. ..	1	15/16 — 1 1/16
75,000	5	—	Brisbane Electric Tram Investment Co., Ltd., Ord.	5	1 — 1½
75,000	5	2/6	Do. 5% Cum. Pf. ..	5	4 — 4½
£425,000	Stk	4½%	Do. 4½% 1st Deb. Stk., Red.	100	95 — 98
£200,000	Stk	6%	Brit. Columbia Elec. Rly. Co., Ltd., Def. Ord. Stock	100	106 —109
		5%	Pref. Ord. Stock	100	102—105
133,301	10	6/-	Brit. Electric Traction, Ltd., Ord.	10	8¼ — 8¾*
156,437	10	6/-	Do. 6% Cum. Pref.	10	11 — 11½
£1,000,000	Stk	5%	Do. 5% Perp. Deb. Stk. ..	100	122 —124
£250,000	Stk	4½%	Do. 4% 2nd Deb. Stk. Red. .	100	97 — 99
100,000	5	2/6	Buenos Ayres & Belgrano Electric Trams, Ltd., Ord.	5	3 — 3¼
40,500	5	3/-	Do. "A" 6% Cum Pref. ..	5	5 7/16 — 5 11/16
27,000	5	3/-	Do. "B" do.	5	4¾ — 5¼

ELECTRIC TRACTION.—*Contd.*

Present Amount Subscribed.	Shares.	Last Dividend.	Name.	Paid up.	Closing Prices.
£200,000	Stk	5%	Buenos Ayres Elec. Trams Co. (1901) Ltd., 5% Db. Stk., Red.	100	96 — 98
£220,000	100	6%	Buenos Ayres Gd. Nat., Ltd., 6% 1st Deb. Bds.	100	100 —103
102,268	5	5/-	Calcutta Tramways Co., Ltd. ..	5	9¼ — 9¾
£350,000	Stk	4½%	Do. 4½% 1st Deb. Stk., Red.	100	107 —109
480,000	1	6d.	Cape Electric Tramways, Ltd. ..	1	1⅜ — 1⅝*
40,000	5	2/6	City of Birmingham Trams Co., Ltd. 5 % Cum. Pref.	5	4⅞ — 5⅛
£800,000	100	4%	Do. 4% 1st Mort. Debs. ..	100	99 —102
£120,000	Stk	5%	Colombo Elec. Tram. & Light. Co., Ltd., 5% 1st Mort. Deb. Stk. Red.	100	103 —105
60,000	10	6/-	Dublin United Trams. Co. (1896), Ltd., Ord. ..	10	13½—14½*
59,987	10	6/-	Do. 6% Pref...	10	15 — 16*
30,000	5	2/6	Isle of Thanet Elec. Trams. and Light. Co., Ltd., 5% Cum. Pref.	5	2½ — 3
£150,000	Stk	4%	Do. 4% Deb. Stock.. ..	100	83 — 88
125.000	10	5/-	London United Trams. (1901), Ltd., 5% Cum. Pref.	10	9¾—10½
£1.031,000	Stk	4%	Do. 4% 1st Mort. Deb. Stk. Red.	100	99 —102
£50,000	Stk	5%	Madras Electric Trams (1904), Ltd., 5% Deb Stock, Red.	100	102 —104
314,016	1	—	Metropolitan Elec. Trams, Ltd., Def.	1	½ — 9/16
500,000	1	6d.	Do. 5% Cum. Pref... ..	1	1 — 1 1/16
£350,000	Stk	4½%	Do. 4½% Deb. Stock, Red.	100	104 —106
50,000	5	6/-	New General Traction Co., Ltd., 6% Cum. Pref.	5	½ — 1½
110,923	8	3/2⅖	North Metropolitan Tramways Co. .	8	4½ — 4¾
£150,000	100	3½%	Do. 3½% Mort. Debs.	100	93 — 98
£196,200	Stk	5%	Perth Electric Trams, Ltd. (W.A.) 5% 1st Mort. Deb. Stock, Red. .	100	103 —106
24,500	10	10/-	Potteries Elec. Traction Co., Ld., Or.	10	8¾ — 9¼
24,500	10	5/-	Do. 5% Cum. Pref. ..	10	9¼ 9¾
£220.000	Stk	4½%	Do. 4½% Deb. Stk., Red.	100	101 —104

IV.—ELECTRIC LIGHTING AND POWER.

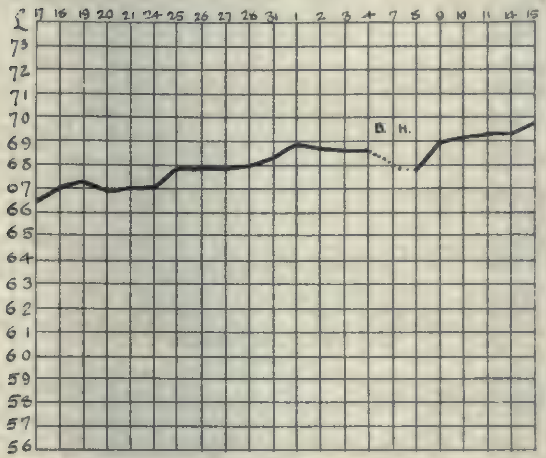
Present Amount Subscribed.	Shares.	Last Dividend.	Name.	Paid up.	Closing Prices.
7,500	10	14/-	Bournemouth & Poole Elec. Sup. Co., Ltd., Ord. ..	10	11¾ — 12¼
7,500	10	4/6	Do. 4½% Cum. Pref. ..	10	10 — 10½
7,500	10	6/-	Do. 6% Cum. Second Pf. ..	10	11½ — 12¼
£70,000	Stk	4½%	Do. 4½% Deb. Stock Red ..	100	105 —107
14,000	5	3/6	Bromley (Kent) Elec. Lt. & Pr. Co. Ld	5	5¼ — 5¾
£50,000	Stk	4½%	Do. do. 4½% 1st Deb. Stk. Red.	100	103 —106
27,507	5	5/6	Brompton & Kensington Elec. Supply Co., Ltd. Ord. ..	5	10 — 10½
12,493	5	3/6	Do. 7% Cum. Pref. Shares..	5	9¾ — 10¼
60.000	5	5/-	Calcutta Elec. Sup. Cor. Ltd., Ord. .	5	9 — 9½
£288,782	Stk	4%	Central Elec. Sup. Co., Ltd., 4% Gua. Deb. Stk. ..	100	103 —106
70,000	5	4/-	Charing Cross & Strand Elec. Sup. Corp., Ltd., Ord... ..	5	6¾ — 7¼
80,000	5	2/3	Do. do. 4½% Cum. Pref...	5	5¼ — 5¾
£350,000	Stk	4%	Do. do. 4% Deb. Stk. Red.	100	103 —105
41,436	5	3/9	Chelsea Elec. Sply. Co., Ltd., Ord.	5	6 — 6½
£150,000	Stk	4½%	Do. do. 4½% Deb. Stk., Red	100	108 —110
70,595	10	7/-	City of London El. Lghtg. Co., Ld., O.	10	10½—11
40,000	10	6/-	Do. 6% Cum. Pref.	10	13 — 14
£400,000	Stk	5%	Do. 5% Deb. Stk., Red ..	100	122 —126
£300,000	Stk	4½%	Do. 4½% 2nd Deb. Stk., Red	100	103 —105
40,000	10	5/-	County of London Elec. Supply Co., Ltd., Ord.	10	8⅝ — 9⅛
30,000	10	6/-	Do. 6% Cum. Pref.	10	12 —12¾
£400,000	Stk	4½%	Do. 4½% Deb. Stk., Red. ..	100	111 —114
70,000	5	2/6	Edmundson's Elec. Cor. Ltd., Ord.	5	5¾ — 6¼
70,000	5	3/-	Do. 6% Cum. Pref.	5	6⅛ — 6⅜
£300,000	Stk	4½%	Do. 4½% 1st Mort. Db. Stk. Reg	100	105 —108
£80,000	Stk	5%	Electric Lighting & Traction Co. of Australia, Ltd. 5% Deb. Stk. Red.	100	85 — 90
10,000	5	/6	Folkestone Elec. Supply Co., Ld., O.	5	5¼ — 5¾
£50,000	Stk.	4½%	Do. 4½% 1st Deb. Stk., Red.	100	99½ —102*
15,000	10	—	Havana Electricity Co., Ltd... ..	10	9½ — 10½
13,000	5	5/-	Hove Elec. Lighting Co., Ltd., Ord.	5	7¾ — 8¼
£50,000	Stk	4½%	Isle of Wight Electric Light & Power Co., Ltd. 4½% Deb. Stock, Red.	100	100—103
150,000	1	—	Kalgoorlie Electric Power & Lighting Corp, Ltd., 6% Cum. Pref.	1	¾ — ⅞
21,000	5	5/-	Kensington and Knightsbridge Electric Lighting Co., Ltd., Ord. ..	5	11¾—12¼

Stocks and Shares marked * are quoted ex-dividend.

THE HOME METAL MARKET.

SHOWING DAILY FLUCTUATIONS FROM JULY 17TH TO AUGUST 15TH, 1905.

COPPER.



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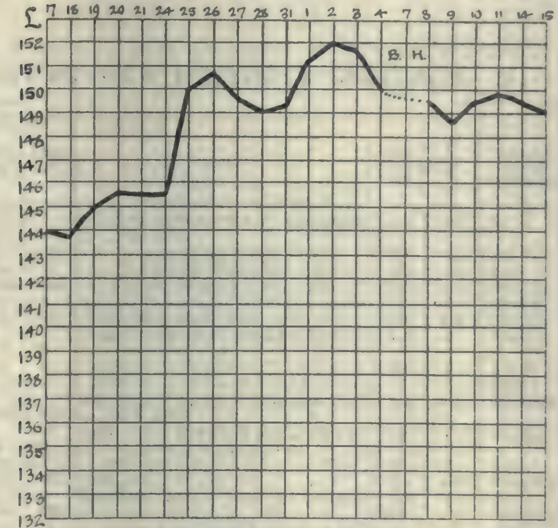

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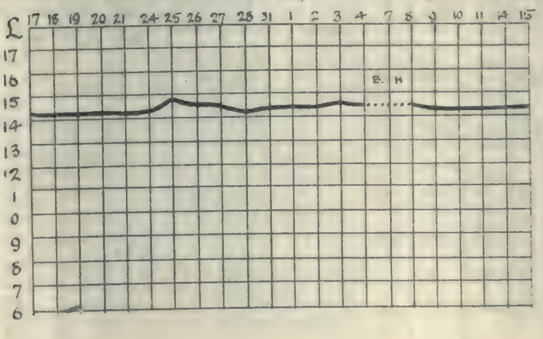
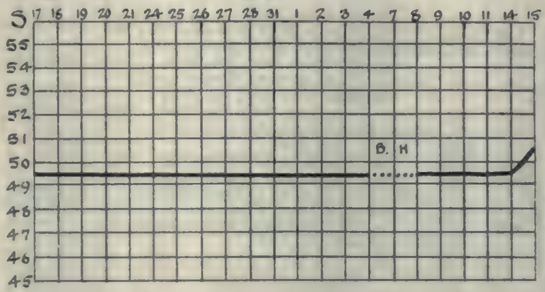


PIG IRON: SCOTCH,



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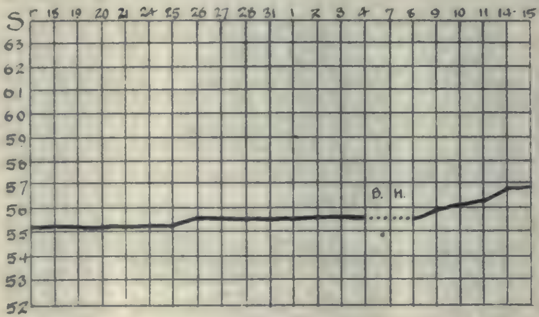
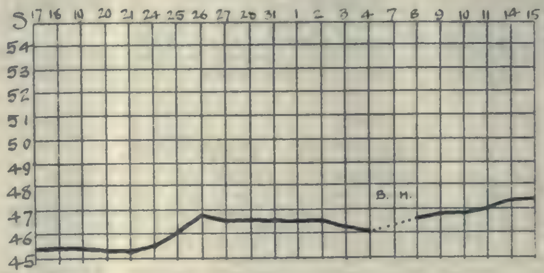
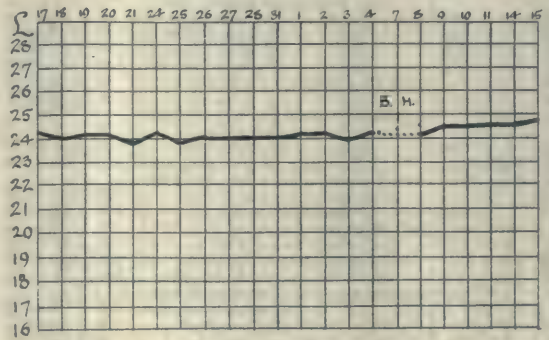


CLEVELAND.



SPELTER.



PRICES CURRENT OF COAL, IRON, STEEL, AND OTHER METALS.

MANUFACTURERS' AND MERCHANTS' QUOTATIONS.

MARKET REPORT.

Wednesday, August 16th, 1905.

IN the Copper market the scarcity of refined is beginning to affect the standard market, and although business has been a little restricted, quotations show renewed firmness, the quotation having improved to £69 7s. 6d. cash and three months. There is no doubt that the position of the metal has been affected by recent heavy shipments to the East, but it is always to be borne in mind that quotations are reaching the point where they act as a direct stimulus to production, a factor to be borne in mind when framing an estimate as to the future course of the metal.

The Tin market has been less strong on lower Eastern prices and realisations by weak holders. The statistical position, however, favours a resumption of operations for the rise, and indeed the latest tendency is again upwards, the market closing firm at £148 15s. od. cash, and £148 three months.

The high premium demanded for spot delivery of Lead has run off with the more liberal supply of Spanish and Australian brands. It is known, however, that consumers are by no means well covered, and at the lower prices ruling there has only been a shadow of the demand that was anticipated, so that it is difficult to see any permanent set-back in the market taking place. As a matter of fact the latest prices indicate some recovery, soft foreign prompt closing at £13 17s. 6d. with English quoted at £14 2s. 6d.

Spelter has been strong on good buying for the home trade. As Merton and Co.'s circular points out, consumption in this country both for galvanised iron and yellow metal is excellent, while sheet zinc has also been in steady request. Stocks everywhere are exceedingly low, and a further rise is likely to take place in the market. August delivery is quoted £24 10s. od., a firm close being reported.

In the Iron and Steel section the outlook is brighter; consumers have been buying pig iron more freely and prices are rather harder. Steel makers have been booking a large amount of work; shipbuilding orders have been given out more freely, and the malleable iron trade continues to improve. This has been reflected in the speculative markets and Cleveland has improved to 47s. 5d. cash and 47s. 8d. one month.

IRON, STEEL, PIG-IRON, &c.

SCOTLAND.

Messrs. David Colville and Sons, Ltd., Dalzell Steel and Iron Works, Motherwell, N.B., quote as follows. Prices delivered in Glasgow or equal:—

Steel:		£	s.	d.
DALZELL	Siemens' Steel Plates, Marine Boiler Quality ..	6	15	0
♛♛	,, ,, ,, Land ,, ,, ...	6	17	6
STEEL	,, Steel Bars, Boiler Quality	6	17	6
DALZELL	Siemens' Steel Plates, Ship Quality Plates......	5	17	6
♛	,, ,, Bars ,, ,, ...	6	7	6
STEEL	,, ,, Angles..........	5	7	6

Manufactured Iron:

	£	s.	d.
Bars—Dalzell..	6	2	6
,, Best	6	12	6
,, ,, Horseshoe	6	12	6
,, Angle..............	6	2	6
,, Best Angle	6	12	6
,, Best Best	7	2	6
,, Extra Best	7	12	6

Usual terms and extras.. Special rates for delivery in England and export. The above prices subject to alteration without notice.

The Glasgow Iron and Steel Co., Ltd., Wishaw, quote as under (prices are delivered Glasgow or equal):—

(Glasgow ♛ Steel)	£	s.	d.	
Steel Angles	5	7	6	per ton.
Steel Ship Plates	5	17	6	,,
Steel Bars, Ship Quality	6	7	6	,,
Glasgow ♛ ♛ Steel.				
Steel Bars, Boiler Quality	6	17	6	,,
Steel Land Boiler Plates	6	7	6	,,
Steel Marine Boiler Plates	6	7	6	,,

Less 5 per cent. discount. Extras as per standard list.

Special prices for delivery in England and for export. The above prices subject to alteration without notice.

John Spencer (Coatbridge), Ltd., Phœnix Ironworks, Coatbridge, N.B., quote:—

	£	s.	d.
Bars—Phœnix	6	5	0
,, Best	6	15	0
,, Best Best	7	5	0
,, Extra Best..	7	15	0
,, Best Horse Shoe	6	15	0
,, Extra B.H.S.	7	15	0
,, Extra Best Cable	8	5	0
,, Rivet	6	5	0
,, Best Scrap Rivet	7	5	0

	£	s.	d.
Angles—Phœnix	6	5	0
,, Best	6	15	0
,, Extra Best	7	5	0
Gas Tube Hoops—Phœnix Best	6	15	0
Plates—Phœnix	—		
,, Best Boiler	7	10	0
,, Best Best Boiler	8	0	0
,, Extra Best Boiler	9	0	0
Boiler Tube Strips—Phœnix Best Best	8	0	0

All per ton, delivered f.a.s., Glasgow, Greenock, Grangemouth, Granton, Leith, or Ardrossan. 5 per cent. discount cash monthly.

Messrs. R. Feldtmann and Co., of Glasgow, quote Commission extra).

Pig Iron:	No. 1.			No. 3.		
	£	s.	d.	£	s.	d.
Coltness, f.a.s. Glasgow	3	5	0	2	13	0
Gartsherrie ,,	2	17	6	2	12	6
Summerlee ,,	2	17	0	2	12	0
Carnbroe ,,	2	14	0	2	12	0
Langloan ,,	3	0	0	2	15	0
Calder ,,	2	17	6	—		
Clyde ,,	2	16	6	2	11	6
Glengarnock, f.o.b. Ardrossan	2	17	0	2	12	0
Eglinton ,, ,,	2	13	0	2	10	6
Dalmellington, ,, Ayr	--			2	12	0
Shotts ,, Leith	2	17	6	2	12	6

NORTH OF ENGLAND.

Messrs. W. Whitwell and Co., Ltd., Thornaby Ironworks, Stockton, quote as follows, **at works:—**

	£	s.	d.
W.W. ♛ Bars	6	12	6
W.W. Best Bars	7	2	6
W.W. Best Best	7	12	6
W.W. Best Best Best	8	2	6
W.W. Best Shoe	7	2	6
Thornaby ♛	8	2	6
Thornaby Best	8	12	6
Thornaby Best Best	9	12	6
Whitwell Special Admiralty Cable	10	5	0
Special Chain Iron	9	5	0
Tube and Nail Strips	6	15	0
W.W. ♛ Angle Iron	6	15	0
W.W. Best Angle Iron	7	5	0
Tee Iron, to 8-inches United	7	12	6

Terms, Cash, less 2½ per cent. discount on 10th of month following delivery.

LANCASHIRE.

The Pearson and Knowles Coal and Iron Company, Ltd. Dallam and Bewsey Forges, Warrington, quote:—

		Iron.			Steel.		
		£	s	d.	£	s.	d.
♛ (BNF)	Bars	6	10	0	6	15	0
	Angles	7	0	0	7	5	0
	Tees	7	10	0	7	15	0
♛ W.I.W	Hoops	7	0	0	7	10	
	Sheets	7	10	0	8	0	

Ordinary Sizes, F.A.S. Liverpool in 10-ton Lots.

Extras for Sizes and Cutting as per List

WORCESTERSHIRE.

Baldwins Ltd. (with which is amalgamated Knight and Crowther, Ltd.), Wilden Works, near Stourport, quote:—

Black Sheets	Singles 20 G 96in. by 36in. per ton.			Doubles 21 G to 24 G 96in. by 36in. per ton.		
	£	s.	d.	£	s.	d.
"Vale"	10	0	0	10	10	0
"Shield"	10	10	0	11	10	0
"Severn"	11	10	0	12	10	0
"Baldwin Wilden B."	12	10	0	13	10	0
Charcoal	16	10	0	17	10	0
Best Charcoal	18	10	0	19	10	0

Pickled, cold-rolled and close annealed sheets specially quoted for.

Extra widths, Singles to 66in., Doubles to 56in., Lattens to 46in. Extra lengths, Singles to 168in., Doubles to 132in., Lattens to 108in.

Patent Coated Sheets:	£	s.	d.	£	s.	d.
No. 3 Lead	13	10	0	14	10	0
S.V. Lead	15	0	0	16	0	0
No. 3 Terne	15	0	0	16	0	0
S.V. Terne	16	10	0	17	10	0

Tinned Sheets:	Singles 20 G to 108 by 36in. per ton.			Doubles 21 to 24 G to 96 by 36in. per ton.		
	£	s.	d.	£	s.	d.
Best Coke (Finish)	29	0	0	30	10	0
,, Charcoal (Finish)	31	0	0	32	10	0
Extra ,, ,,	33	0	0	34	10	0

Cotton Can Tin Sheets to 39in. by 36in. specially quoted for.

Tin Plates, "Cookley, K" Best Charcoal, £1 7s. 0d. per box.

Extreme sizes in Tin and Patent Coated specially quoted for.

Lattens up to 36 wide by 27 W.G. £1 10s. 0d. per ton extra throughout for all brands.

At works.

Galvanized Corrugated Sheets:

	£	s.	d.	
"Phœnix" Brand, 24 G., f.o.b. London, in Bundles	12	0	0	per ton.
"Blackwall" Brand, 26 G., in felt-lined cases for Australia, f.o.b. London	14	5	0	,,

Galvanized Working Up-Sheets:

	£	s.	d.	
24 G., f.o.b. London, in Bundles	13	0	0	per ton.

STAFFORDSHIRE.

Shelton Iron, Steel, and Coal Co., Ltd., Stoke-on-Trent, North Staffordshire, and 122, Cannon Street, London, quote:—

	£	s.	d.	
Crown Bars	6	10	0	per ton.
Best Bars (1 to 6in. wide, above ¼ in. thick, ½ in. to 4 rounds and squares)	7	0	0	,,
Angles	6	15	0	,,
,, Best	7	5	0	,,
T's	7	0	0	,,
,, Best	7	10	0	,,
Best Shoe Iron	8	0	0	,,
,, Rivet Iron	8	0	0	,,
,, Best Rivet (Special)	9	5	0	,,
,, Cable	9	5	0	,,
,, Screwing	8	5	0	,,

	£	s.	d.	
Best Turning	8	0	0	per ton.
,, Plating	8	5	0	,,
Best Best	9	5	0	,,
Treble Best	10	5	0	,,
Plates	7	10	0	,,
Best Plates	8	0	0	,,
,, Boiler Plates	8	10	0	,,
,, Best Boiler Plates	9	10	0	,,
Treble Best Boiler Plates	12	0	0	,,

Delivery f.o.b. Liverpool, Birkenhead or Manchester.

WALES.

Cordes (Dos Works), Ltd., of Newport, Mon., quote " Star " brand patent wrought nails steel nails, &c.

Discounts—

45 per cent. off 1-inch to 3-inch strong rose and all fine rose and 6dy. and 8dy. pound.

40 per cent. off 3½-inch to 7-inch strong rose and 10dy. and 20dy. pound.

40 per cent. off all sharp-pointed nails.

Delivered in lots of 4 cwt. and upwards. Extra 2½ per cent. discount off the gross on two tons and upwards.

Steel rose, flat points, 5-inch to 7-inch basis :—

2 tons 9/6 per cwt.
4 cwt. lots and upwards 9/9 per cwt. } d/d any Railway Station.

Steel cut nails, 3-inch basis—

2 tons 8/3 per cwt.
4 cwt. lots 8/6 per cwt. } d/d any Railway Station.

Slit rods (iron) £7 10s. per ton, at works for 2-ton lots.

Messrs. Richard Thomas and Co., Ltd., of 33 and 35, Eastcheap, E.C. — Works: South Wales, Burry, Lydney, Lydbrook, and Cwmbwrla, quote :—

	Per Box. f.o.b. Wales. £	s.	d.
Coke Tin-plates.			
C 18¾ by 14 124s. 110 lb. " BV "	0	12	4½
C 20 by 10 225s. 155 ,, " Jumbo "	0	17	4½
C 20 by 14 112s. 108 ,, " Lydbrook "	0	12	0
C 28 by 20 112s. 216 ,, " Lydbrook "	1	4	3
Charcoal Tinplates :			
C 20 by 14 112s. 108 lb. " Allaway "	0	12	9

BELGIUM.

C. L. Faulkner, Suffolk House, Laurence Pountney Hill, London, E.C., quotes :—

Prices quoted are in £ stg. and per ton of 1,015 kos. (2,240 lb.) delivered free on board ANTWERP for approved quantities.

		£	s.	d	
Steel :					
Blooms	at	3	16	0	per ton.
Billets	at	3	18	0	,,
Sheet Bars	at	4	0	0	,,
Finished Steel :					
Bars	at	5	0	0	per ton.
Angles	at	5	1	0	,,
Tees	at	5	5	0	,,
Joists	at	4	12	6	,,
Fencing Standards	at	5	3	0	,,
Shoeing Bars	at	5	5	0	,,
Tyre Bars	at	5	5	0	,,
Half-Round Bars	at	5	10	0	,,
Heavy Rails	at	5	5	0	,,
Light Rails	at	4	17	6	,,

Structural Steelwork :

Prices on application.

METALS.

Messrs. French and Smith, 147, Leadenhall Street, and 11, Oldhall Street, Liverpool, quote :—

TIN.

Tin :	£	s.	d.		£	s.		
English Ingots, f.o.b. Dis. 1¼% & 1%	149	0	0	to	149	10	0	per ton
English Bars, f.o.b. Dis. 1¼% & 1%	150	0	0	to	150	10	0	,,
Straits G.M.B., cash Warehouse, Net	148	10	0	to	148	15	0	,,
Straits G.M.B., 3 months, Warehouse, Net	148	0	0	to	148	2	6	,,
Australian, Mt. Bischoff, Warehouse, Net	149	5	0	to	149	10	0	,,

COPPER

Copper :	£	s.	d.		£	s	d.	
Standard G.M.B., cash Warehouse, Net	69	5	0	to	69	7	6	per ton.
Standard G.M.B., 3 months, Warehouse, Net	69	5	0	to	69	7	6	,,
English, Tough, Cake & Ingot, Warehouses, Net	72	0	0	to	72	10	0	,,
English, Best Select, Warehouse Net	74	0	0	to	74	10	0	,,
English, Sheets and Sheathing, f.o.b., Dis. 2½%	82	0	0	to	83	0	0	,,
English, Sheets for India, f.o.b., Dis. 2½%	79	0	0	to	80	0	0	,,
Electro, Warehouse, Net .	72	15	0	to	73	0	0	,,
Ore, ex. ship	0	12	3	to	0	13	3	per unit
Regulus, Matte and Precipitate, ex ship,	0	13	6	to	0	14	0	,,

YELLOW METAL.

Yellow Metal :	£	s.	d.	
Sheets, 4 by 4 feet for India f.o.b. Dis. 2½%	0	0	6½	per lb.
Sheathing ,, ,,	0	0	6⅝	,,

SPELTER.

	£	s.	d.		£	s.	d.	
Silesian outports, Net	24	10	0	to	24	12	6	per ton.
Blende of 50 % Net	6	10	0	to	6	12	6	,,
Calamine, Net	6	12	6	to	6	15	0	,,

LEAD.

	£	s.	d.		£	s.	d.	
English Pig, Warehouse, Dis. 2½%	14	5	0	to	14	7	6	per ton.
Spanish, ex ship, Dis. 2½%	13	17	6	to	14	0	0	,,
Lead Ore of 70 %, Net	7	5	0	to	7	7	6	

ANTIMONY.

	£	s.	d.		£	s.	d.	
Star Regulus, f.o.b., Dis. 2½ %	60	0	0	to	62	0	0	per ton.
Ore, 50 %, ex ship, Dis. 2½%	16	10	0	to	18	0	0	,,
Crude, ex ship, Dis. 2½ %	37	0	0	to	40	0	0	,,

QUICKSILVER.

	£	s.	d.	
Spanish, 75 lb., Warehouse, Net	7	7	6	per flask
Italian ,, ,, ,,	7	5	6	,,

COAL.

LEICESTERSHIRE.

The Nailstone Colliery Company, Leicester, quote. Price per Ton at Pit of 20 Cwt., with $\frac{1}{2}$ Cwt. per Ton for wastage —

Upper Main Seam.	s.	d.
Main Coal	6	0
Best Hard Steam (hand picked, as used by the Railway Companies)	5	6
Best Hard Steam Cobbles (made through 6 in. mesh, free from slack)	5	6
Fine Slack	1	0

Terms, net cash on 10th of month following delivery.

DERBYSHIRE.

The Manners Colliery Co., Ltd., of Ilkeston quote as follows, per ton at pit:

Kilburn Coal:	s.	d.
Best London Brights	9	9
Large Nuts ($1\frac{1}{2}$ to $3\frac{1}{2}$)	9	6
Small Nuts ($\frac{3}{4}$ to $1\frac{1}{2}$)	6	0
Rough Brights	6	0
Peas ($\frac{3}{8}$ to $\frac{3}{4}$)	5	0
Slack	8	6
Smudge	2	0

Low Main (or Tupton) Coal:

	s.	d.
Low Main Brights	7	6
,, ,, Nuts	7	3
Hards (Good Steam Coal)	8	0
Bakers' Nuts (1″ to 2″)	6	6
Slack	3	6

The Clay Cross Company's Collieries, Clay Cross, near Chesterfield, quote:—

	per ton at pit. s.	d.
Best Main Coal	10	6
Best Silkstone	10	0
Best House Coal	8	6
Best House Nuts	8	0
Treble Screened Cobbles	7	9
Best Cobbles	7	3

NOTTINGHAMSHIRE.

The Digby Colliery Co., Ltd., near Nottingham, quote per ton at pit :—

Digby Coal:

STEAM.	s.	d.
Best Hand Picked Hard	8	6
Steam Hard	7	3
Hard Nuts	6	6

Gedling Colliery.

HIGH HAZEL.		
London Brights, 4 to 8 in. cube	9	6
Bright Cobbles (Hand Picked)	9	0
Large Nuts, 2 to 4 in. cube	8	0
Small Nuts, 1 to 2 in. cube	6	0
Pea Nuts, $\frac{3}{8}$ to 1 in. cube	5	0
STEAM.—TOP HARD.		
Best Hard	8	6
Hard Steam	7	6
Cobbles	6	3

CHEMICALS.

Messrs. S. W. Royse and Co., Albert Square, Manchester, quote:

		£	s.	d.	
Acids:	Oxalic	0	0	$2\frac{1}{2}$	per lb.
	Picric, Crystals	0	0	10	,,
	Tartaric at Manchester	0	0	$10\frac{7}{8}$	,,

		£	s.	d.	
Acetate of Lime:	Brown at Manchester net	8	10	0	per ton.
	Grey ,, ..	11	12	6	,,
Alumina:	Alum, Lump, loose	5	5	0	,,
	,, ,, in casks	5	7	6	,,
	,, Ground, in bags	5	15	0	,,
	Sulphate of Alumina, 14%	4	10	0	,,
Ammonia:	Carbonate	0	0	$3\frac{5}{8}$	per lb.
	Muriate Grey f.o.b. Liverpool	23	15	0	per ton.
	Sal-ammoniac, Lump, 1sts, del$^{d.}$ U.K.	42	0	0	,,
	,, ,, 2nds, ,,	40	0	0	,,
	Sulphate f.o.b. Liverpool	12	5	0	,,
Arsenic:	Best White Powdered net	12	10	0	,,
Bleaching Powder,	35% ,,	4	10	0	,,
Borax:	British Refined Crystal ,,	12	0	0	,,
Coal Tar Products:					
	Benzole, 50/90 % ,,	0	0	6	per gal.
	,, 90% ,,	0	0	7	,,
	Carbolic Acid Crystals, 34/35° C. ... ,,	0	0	$5\frac{3}{4}$	per lb.
	,, ,, ,, 39/40° C. ... ,,	0	0	$6\frac{1}{4}$	,,
	,, ,, Liquid, 97/99 % ... ,,	0	0	9	per gal.
	,, ,, Crude, $62\frac{1}{2}$% at 60° F. f.o.b. ,,	0	1	8	,,
	Creosote, ordinary good liquid ,,	0	0	$1\frac{7}{16}$	,,
	Naphtha, Crude, 20 % at 120° C. ... ,,	0	0	3	,,
	,, Solvent, 90% at 160° C. f.o.b ,,	0	0	8	,,
	,, ,, 95 % at 160° C. ,, ,,	0	0	9	,,
	,, ,, 90 % at 190° C. ,, ,,	0	0	10	,,
	,, Rectified, flash point over 73° F. f.o.b. ,,	0	0	11	,,
	,, Rectified, flash point over 100° F. f.o.b. ,,	0	1	0	,,
	Naphthalene, all qualities.				
	Pitch f.a.s. Manchester. ,,	1	7	6	per ton.
Copperas:	Green, in bulk ,,	0	12	6	,,
	,, barrels f.o.b. L'pool ,,	1	17	6	,,
	Cake ,,	1	2	6	,,
Copper:	Sulphate	21	0	0	,,
Cyanides:	98% minimum f.o.b. net	0	0	$7\frac{1}{2}$	per lb.
Lead:	Acetate (Sugar) White, English	27	10	0	per ton.
	,, ,, ,, Foreign c.i.f. U.K	23	5	0	,,
	,, ,, Grey	21	15	0	,,
	,, ,, Brown at Manchester	16	15	0	,,
	Nitrate	24	10	0	,,
	Litharge, Flake	16	10	0	,,
	,, Powder	17	0	0	,,
	Red Lead, Genuine, c.i.f. London less 5%	16	0	0	,,
	White ,, ,, Dry ,, ,, ,,	17	0	0	,,
Naphtha (Wood):	Miscible, 60 o.p.	0	2	6	per gal.
	Solvent	0	2	7	,,
Potash:	Bichromate... delivered England...	0	0	3	per lb.
	Carbonate, 90/92 % ... c.i.f Hull ...	18	0	0	per ton.
	Caustic, 75/80 % ,, ,, ...	20	10	0	,,
	Chlorate net	0	0	$3\frac{1}{16}$	per lb.
	Montreal in Store, Liverpool	31	10	0	per ton.
	Prussiate Yellow net	0	0	$4\frac{7}{8}$	per lb.

	£	s.	d.	
Soda: Ash, Caustic, 48 %, Ordinary ... net	5	5	0	per ton.
,, ,, ,, Refined ,,	6	5	0	,,
,, Carbonated, 48 % ,,	5	10	0	,,
,, ,, 58 % (Ammonia Alkali) net	4	10	0	,,
,, Bleachers' Refined Caustic 50/52 % net	6	10	0	,,
Caustic, White, 77 % ,,	10	12	6	,,
,, ,, 70 % ,,	9	12	6	,,
,, ,, 60 % ,,	8	12	6	,,
,, Cream, 60 % ,,	8	10	0	,,
Crystals, in bags	3	0	0	,,
,, barrels	3	7	6	,,
Acetate c.i.f. Hull net	16	10	0	,,
Bicarbonate, in 1 cwt. kegs	6	15	0	,,
Bichromate......delivered England...	0	0	2¼	per lb.
Chlorate net	0	0	3 1/16	per lb.
Nitrate.. ex quay Liverpool, ... ,,	10	5	0	per ton.
Phosphate	9	5	0	,,
Prussiate net	0	0	3⅝	per lb.
Silicate, Solution, 140° Tw.	4	10	0	per ton.
Sulphate (Glauber Salts)	1	12	6	,,
,, (Saltcake, 95%)	1	15	0	,,
Sulphur: Recovered	4	15	0	,,
Roll	6	15	0	,,
Flowers	7	10	0	,,
Zinc: Sulphate	6	15	0	,,
Shellac: Standard TN orange spot	9	0	0	per cwt.

MINERALS.

Messrs. S. W. Royse and Co., quote :—

	£	s.	d.	
Barytes: Lump Carbonate, 90/92%	3	10	0	per ton.
Sulphate, No. 1, White	2	15	0	,,
China Clay: of various qualities for all purposes; prices from about 11/- to about 30/- per ton, f.o.b. Cornwall: stocks also kept at Runcorn and Preston. Quotations given carriage paid.				
Chrome Ore: Basis 50% c.i.f. British Ports	3	10	0	,,
Manganese: Lump c.i.f. Liverpool 10¼d. per metallic unit.				
Ochre: French JC f.o.b. Rouen, net	2	5	0	per ton.
,, JF	5	10	0	,,
Talc: (French Chalk) c.i.f. Liverpool	3	10	0	,,

Messrs. Henry Bath and Son, quote :—

	£	s.	d.		£	s.	d.	
Copper, Ores of, 10 to 25%	0	12	0	to	0	13	0	per unit.
Regulus, 45 to 55%	0	13	3	to	0	13	9	,,
Precipitate, 65 to 80% ...	0	13	4½	to	0	13	10½	,,
Tin Ores, 70 %	91	0	0	to	93	0	0	per ton.
Lead Ore, 70%					6	19	0	,,
Blende, 50%					6	9	6	,,
Calamine					6	12	0	,,
Antimony Ore, 50%	20	0	0	to	22	0	0	,, nom.

Messrs. Barrington and Holt, Cartagena, quote :—

Iron Ore.

			s.	d.	
Ord. 50%,	f.o.b.	Porman	6	4	per ton.
Do.	,,	Cartagena	6	7	,,
Special low phos.	,,	Porman	6	10	,,
Do. do.	,,	Cartagena	7	0	,,
Extra quality do.	,,	,,	7	6	,,
Special Iron Ore	,,	,,	nominal		,,
Specular 58% do.	,,	,,	9	6	,,

TIMBER.

Messrs. Alfred Dobell and Co., Liverpool, quote :—

COLONIAL WOODS.

Timber.

		£	s.	d.		£	s.	d.
Quebec Square White Pine...	per cub. ft.	0	1	9	to	0	3	3
Quebec Waney Board Pine...	,,	0	2	8		0	3	9
St. John Pine, 18 in. average	,,	0	2	4		0	3	3
Lower Ports Pine	,,	0	1	3		0	1	8
Quebec Red Pine	,,	0	1	6		0	2	3
Quebec Oak, 1st quality	,,	0	2	9		0	3	4
Quebec Oak, 2nd quality ...	,,	0	1	6		0	2	6
Ash	,,	0	1	6		0	2	3
Elm	,,	0	3	3		0	4	0
Hickory	,,	0	2	0		0	2	6
Quebec Birch	,,	0	1	6		0	2	3
St. John Birch	,,	0	1	6		0	2	0
Birch Planks	,,	0	0	9		0	0	11
Spruce Spars	,,	0	0	10		0	1	0

Deals.

		£	s.	d.		£	s.	d.
1st quality Quebec Pine	per std.	22	10	0	to	32	10	0
2nd do. do.	,,	17	0	0		22	0	0
3rd do. do.	,,	11	10	0		13	0	0
St. John, Miramichi, etc., Spruce	,,	7	2	6		7	7	6
Nova Scotia Spruce	,,	7	0	0		7	5	0
Spruce Boards	,,	6	7	6		6	12	6

UNITED STATES, etc., WOODS.

Pitch Pine.

		£	s.	d.		£	s.	d.
Hewn	per cub. ft.	0	1	4	to	0	1	8
Sawn	,,	0	1	0		0	1	6
Planks, Stowage	,,	0	0	10		0	1	0
Boards, Prime	per std.	12	10	0		16	0	0
Oak Timber	per cub. ft.	0	1	6		0	2	6
Oak Planks	,,	0	1	6		0	2	1
East India Teak	per load	12	0	0		16	0	0
Greenheart	,,	6	15	0		7	10	0

EUROPEAN WOODS.

Timber.

		£	s.	d.		£	s.	d.
Riga Redwood	per cub. ft.	0	1	6	to	0	2	0
Dantzic and Memel Fir, Crown	,,	0	2	1		0	2	6
Dantzic and Memel Fir, Middling	,,	0	1	9		0	1	11
Stettin	,,	0	1	9		0	1	11
Swedish	,,	0	1	0		0	1	3
Riga Whitewood	,,	0	1	0		0	1	3
Norway Mining Timber	,,	0	0	9		0	1	0
Dantzic and Stettin, etc., Oak	,,	0	2	6		0	3	0
Norway Spars	,,	0	1	2		0	1	9

Deals.

		£	s.	d.	£	s.	d.
Red Archangel and Onega, 1st quality	per std	19	0	0	20	0	0
Red Archangel and Onega, 2nd quality	,,	14	0	0	16	0	0
Red Archangel and Onega, 3rd quality	,,	10	10	0	12	10	0
St. Petersburg, 1st quality...	,,	16	0	0	17	10	0
Do. 2nd ,, ...	,,	14	0	0	15	0	0
Gefle	,,	11	10	0	16	0	0
Wyburg	,,	11	0	0	12	10	0
Uleaborg	,,	10	0	0	12	10	0
Gothenburg	,,	11	0	0	16	0	0

SELECTED PATENTS.

Compiled expressly for this journal by **Messrs. Page and Rowlingson, Engineering Patent Agents, 28, New Bridge Street, London, E.C.,** and at Manchester.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton Buildings, Chancery Lane, W.C., at the uniform price of 8d.

NEW PATENTS APPLIED FOR.

When Patents have been communicated the names of the communicators are printed in *italics.*

14947. M. D. Cvetkovic and C. A. Wels, London. July 20th.—Improvements relating to the propulsion of boats.

14963. A. H. Mazeraud, London. July 20th.—Improvements in means for utilising waste steam. (Date applied for, July 25th, 1904.)

14988. G. M. Marchant, Huddersfield. July 21st.—Improvements in or appertaining to valves.

15010. S. Butterworth, Manchester. July 21st.—Improvements in apparatus for regulating the admission of air to the furnaces of steam boilers, and for the better consumption of smoke therein.

15020. W. Lampitt, London. July 21st.—Improvements in submarine and like vessels.

15033. T. F. J. Truss, London. July 21st.—Improvements in or relating to submarine vessels.

15038. J. W. Butler and H. C. Brewster, London. July 21st.—Improvements in wrenches.

15060. The Hon. C. A. Parsons, London. July 21st.—Improvements in steam turbines.

15068. The Warwick Machinery Co., Ltd., London. July 21st.—Improvements in nozzles for elastic fluid turbines. (*The General Electric Co., U.S.A.*)

15069. The Warwick Machinery Co., Ltd., London. July 21st.—Improvements in and relating to elastic fluid turbines. (*The General Electric Co., U.S.A.*)

15070. The Warwick Machinery Co., Ltd., London. July 21st.—Improvements relating to elastic fluid turbines. (*The General Electric Co., U.S.A.*)

15072. W. B. Sayers, London. July 21st.—Improvements pertaining to the production of motive power by means of rotary motors or turbines.

15075. F. Gandy, London. July 21st.—Means for enabling attention to be attracted to communication to be established with and air supplied to sunken and disabled submarine vessels.

15107. R. H. Marten, London. July 22nd.—Improvements in and relating to automatic pressure reducing valves.

15111. C. Helas, London. July 22nd.—Improvements in valve attachments for water heaters and the like.

15112. C. Helas, London. July 22nd.—Improvements in valve attachments for water heaters and the like.

15130. W. L. Miller, London. July 22nd.—Blowing off, washing, and filling apparatus for boilers. (Date applied for, February 23rd, 1904.)

15,623. P. F. C. Willcox, Sunderland. July 31st.—Improvements in mechanical lubricators.

15,631. H. Schofield and O. P. Macfarlane, London. July 31st.—Improvements in furnace bridges.

15,641. H. A. Fredlund, London. July 31st.—Improvements in rotary steam engines.

15,653. J. F. Liebentritt, London. July 31st—An improved multiple pump.

15,662. E. Zappa and A. J. Schars, London. July 31st.—Improvements in water-tube boilers. (Date applied for, August 5th, 1904.)

15,666. S. Davis, London. July 31st.—Improvements in and relating to governors.

15,688. G. Hough, Wolverton. August 1st.—Improvements in and connected with variable speed and power mechanism.

15,727. W. Cassie, Englefield Green. August 1st.—Improvements in the balancing of engines.

15,728. W. Cassie, Englefield Green. August 1st.—An internal combustion engine.

15,757. H. Hellman and L. C. Bayles, London. August 1st.—Improvements in rock-drilling machines.

15,772. R. Haddan, London. August 1st.—Improvements in water-tube boilers. (*Prince Robert de Broglie, France.*)

15,781. G. W. Beynon, Mortimer. August 2nd.—Improvements in machinery for pulverising, crushing, and the like.

15,846. W. M. Still, London. August 2nd.—Improvements in valves.

15851. L. Creux, London. August 2nd.—A new or improved rotary engine.

15936. A. Lehmann, London. August 3rd.—An improved rotary internal combustion engine.

15942. E. Breare, Addingham. August 4th.—Improved steam or water turbine engine.

15965. H. S. Broom and J. T. Wade, London. August 4th.—Improved automatic unloading device for air compressors and the like.

16006. Sir W. Palmer, London. August 4th.—Improvements in internal combustion engines.

16022. T. A. Rees, London. August 4th.—Improvements in internal combustion engines.

16084. H. Grade, London. August 5th.—Inlet valve for two-cycle explosion engines. (Date applied for, August 8th, 1904.)

RECENT SPECIFICATIONS.

IMPROVEMENTS IN AIR PUMPS.

R. H. Davis and Siebe, Gorman and Co., Ltd., London. June 29th, 1905.—This invention relates to improvements in air pumps having two double-acting or four single-acting cylinders and mainly consists in providing means whereby such pumps can be employed for employing air either to one or two divers as may be desired. According to this invention the valve-box is provided with a partition dividing it into two parts, each part having one set of inlet and outlet valves in the case of the two-cylinder double-acting pumps, and two sets in the case of the four-cylinder single-acting pumps. Above the valve-box is an air distributor communicating with the two compartments. The air distributor has two discharge pipes, and is provided with a hollow plug cock preferably placed vertically, and is formed with an orifice; by turning the cock this orifice can be brought either into the position shown in fig. 4 or into that indicated in fig. 5. In the former case the two divers are supplied with air from the discharge pipes, each of which receives its air from the cylinder with which it is in connection. In the latter case, that is to say, when the cock is turned, as shown in figs. 3 and 5, the supply of air is cut off from the discharge pipe seen on the left in fig. 2, the quantity which previously passed through this discharge pipe flowing through the orifice in the cock and through the discharge pipe seen on the right of fig. 2, together with that supplied directly from the corresponding valve-box compartment. In the accompanying drawings fig. 1 is a sectional side elevation of a double-acting air pump having the improvements applied thereto. Fig. 2 is a sectional view at right angles to fig. 1, illustrating the air delivery device. Fig. 3 is a section on the line 3—3 of fig. 1. Fig. 4 is a section on the line 4—4 of fig. 3. Fig. 5 illustrates the different position of the cock, and fig. 6 is a plan of the cock shown in fig. 3.

Fig. 1.

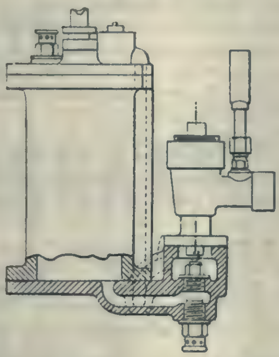


Fig. 2

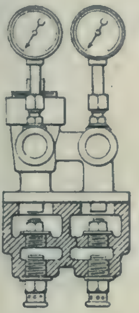


Fig. 4.

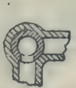


Fig. 3.

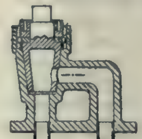


Fig. 5.

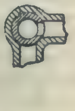


Fig. 6

IMPROVEMENTS IN AND RELATING TO ELECTRIC CIRCUIT BREAKERS.

Crompton and Co., Ltd., and R. C. Harris, Chelmsford. June 29th, 1905.—This invention relates to improvements in electric circuit breakers and to new combinations of details whereby the construction is simplified, cheapened, and made more compact. Fig. 1 is a front view of the circuit breaker, with handle removed; fig. 2 is a side view, partly in section; fig. 3 is a view of the underside of the circuit breaker. In carrying out this invention, a main brush or connecting bar, preferably of high conductivity metal, is used, bridging two or more main contacts, also of metal, arranged upon a base which may be of insulating material. If the base is not of insulating material, means are provided to insulate all "live" parts of the circuit breaker from it. Auxiliary "sparking" contacts, preferably of metal having a high fusing point or carbon, are also used, which "sparking" contacts engage with other pieces carried by an extension on the main brush. The brush is carried directly on the spindle to which it is attached by the carrier. This spindle passes through a bush in the base, and this bush may be conveniently arranged to carry a detent which locks the switch in the closed position as well as to form a bracket upon which a releasing weight is pivoted, as illustrated. The spindle is provided with an arrangement to prevent the brush turning, and has also a catch on its underside, which is arranged to engage with the detent. The circuit breaker is preferably automatically actuated by a thermal plate, but it must be understood that any of the well-known magnetic, thermal, or other suitable form of gear for actuating the tripping catch may be used. The thermal plate (fig. 4) is preferably made up of two or more pieces of metal, and when this plate becomes heated, due to the passage of a current, both the iron and the brass strips expand, but the brass more than the iron, and this causes the plate to bend up, and as one end of the plate is fixed, all the movement must take place at the free end, to which is connected the flexible conductor. Upon the free end of the thermal plate there is fixed a plate, but insulated therefrom. This engages with an adjustable screw in the weight. When the thermal plate bends up, due to an overload, this said plate disengages itself from the screw, and allows the weight to fall. This weight in falling strikes the detent and releases it, thus allowing the spring shown to force the brush off the contact and break circuit, the forward movement of the spindle re-setting the weight. The circuit breaker may be discharged by hand by means of the knob if necessary. This does not necessitate the thermal plate being forced into a bent position and strained.

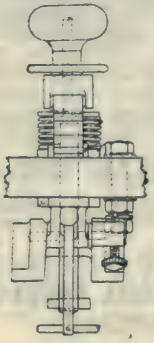


FIG: 3

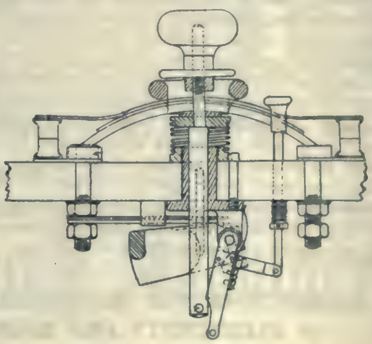


FIG: 2

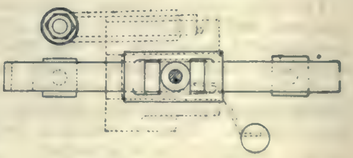


FIG: 1

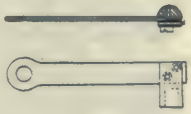


FIG: 4

NEW PUBLICATIONS.

"BROWN'S MARINE ELECTRICIAN."

Containing concise information and practical hints on the installation and maintenance of electric plant, for sea-going engineers; with answers to Board of Trade questions in electricity. By A. E. Larkin, A.I.E.E., and A. Lindsay, A.M.I.E.E. James Brown and Son. 3s. 6d. net.

This useful little handbook should be in the possession of every marine engineer whose duties necessitate a knowledge of such matters as the installation, repair, and use of electric lighting, heating and other appliances suitable for ships. Profusely illustrated with diagrams, the work is written in a style eminently suitable for the practical man, while the answers to the questions set by the Board of Trade are characterised by commendable brevity and lucidity. In order to facilitate reference the work is arranged under the following heads: first principles; the dynamo; batteries, voltage, resistance; lamp, wiring switches; instruments, testing, faults; electrical heating and cooking; electrical bells and indicators.

"MODERN LIGHTNING CONDUCTORS."

By Killingworth Hedges, M.Inst.C.E. Crosby, Lockwood and Son. 6s. 6d. net.

Issued as a supplement to the recently published report of the Lightning Research Committee, this volume, containing some valuable data relating to the method of protection and specifications, should be perused by all those interested in schemes for protecting buildings from lightning. Sir Oliver Lodge's introduction to the report is here reprinted, and sets out clearly the theory of lightning and indicates the means by which buildings may be protected, while some of the more important chapters deal with systems used in Belgium, France, Italy and America. The book is profusely illustrated by photographs and sketches, showing the effect of lightning on protected and unprotected buildings.

"ELEMENTS OF THE MATHEMATICAL THEORY OF ELECTRICITY AND MAGNETISM."

By J. J. Thomson, M.A., D.Sc. Cambridge University Press. 10s.

The aim of Dr. Thomson's treatise, which has already reached its third edition, is to give an account of the fundamental principles of the mathematical theory of electricity and magnetism and their more important applications by the aid of simple mathematics. At the outset the author fully discusses the general principles of electrostatics. This is followed by chapters on lines of force; capacity of conductors; condensers; specific inductive capacity; electrical images and inversion; magnetism; terrestrial magnetism; magnetic induction; electric currents; magnetic force due to currents; electro-magnetic induction; electrical units; dimensions of electrical quantities; dielectric currents and the electro-magnetic theory of light; thermoelectric currents, and a new chapter on the properties of moving electric charges, which give an outline of the theoretical analysis Professor Thomson has already dealt with fully in other works. The writer claims that with the exception of a few paragraphs, no more advanced mathematical knowledge is required than an acquaintance with the elementary rules of the differential calculus. The work, which is thoroughly up-to-date, is one we can confidently recommend to all young students of electrical engineering.

NEW CATALOGUES.

The East Anglian Engineering Company, Ltd., Stowmarket, Suffolk, have sent us a copy of their illustrated quarterly list of "Bull" electric motors, which they claim are British throughout, and do not consist of foreign made parts assembled in England.

Warwick's Time Stamp Company, 134, Highbury Hill, London, N.—The subject of a new circular produced by this firm is the Warwick Alarm Meter, for use in the photographic dark room. This is constructed with a lever timepiece contained in a polished mahogany case with nickel-plated fittings. The metal dial is divided into spaces from 1 to 60 minutes, and these are in relief. The setting hand has a handle for pressing it over the raised beads around the dial, and setting the alarm to act as wanted by the sense of touch aided by sound, in the dark entirely. A start lever at the side is raised to set the timepiece going, and when the registering hand passes zero on the dial, an audible alarm is automatically released. It may be set to act from 30 seconds to 1 hour. If required, the meter can be supplied to act in "seconds" instead of "minutes"; also the descending alarm lever may collapse a squeegee and operate an exposure shutter, or make an electric contact and give an alarm at a distance.

Western Electric Company.—In connection with street railways and electric tramways the need has arisen for means of communication between drivers or motor men and the generating station and engineers. A telephone set, devised for this purpose by the above company, is illustrated in a special circular. The outer case consists of a cast-iron box with ample flanges to ensure protection from damp weather. It is in a form suitable for mounting on the side of a feeder pillar or trolley pole. The set is also made up in cases without lugs, suitable for mounting on the top of cast-iron pillars. To effect the call the motor man turns the generator crank a few times, and then by means of the combined transmitter and receiver, of the form commonly known as a microtelephone, converses with the engineer at the station. At the upper part of the set are two projecting rods; these engage with the anvils cast in the front of the outer door and operate switches, which, respectively, open the transmitter circuit and cut the apparatus entirely clear from the line when the door is closed. This is an important part of the set, for the automatic opening of the battery circuit prevents waste of the current, and the opening of the line circuit serves the double purpose of preventing damage to the set in the event of a cross of the telephone line with the traction circuit, and permits an unlimited number of these circuits to be placed in "bridge" across one pair of lines which may thus serve for a whole route, or, in small systems, for the whole network, and thus save the expense of providing switching apparatus at the generating station. All the apparatus is mounted on a sliding base which runs in guides cast in the side of the set, this arrangement enabling the whole to be removed into a convenient position for inspection. An important feature of this set is that the protective apparatus and the telephone apparatus are arranged in separate groups with an earthed metallic shield between them, so that any dangerous high potential condition that may exist in the compartment wherein the protective devices are mounted may not be communicated to the telephone apparatus, but may instead be diverted through the shield.

PAGE'S WEEKLY Miscellaneous

AGRICULTURAL HALL, 1905.
TRAMWAY EXHIBITION.

AN UNPARALLELED EXHIBIT.

"IGRANIC"
RHEOSTATS.

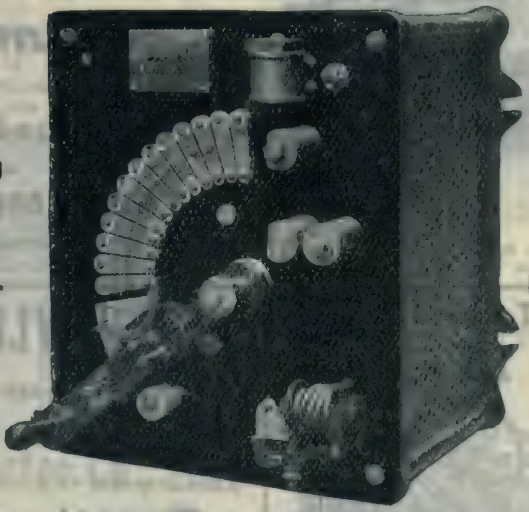


FIG. 2.—RENEWABLE CONTACT TYPE.
Used from 55 amperes upwards.

"IGRANIC"
RHEOSTATS.

STURTEVANT ENGINEERING CO., LTD.,
147, Queen Victoria Street, E.C.

Ice Making and Refrigerating Machinery.

CARBONIC ANHYDRIDE (CO_2).

AMMONIA COMPRESSION and LOW PRESSURE ETHER SYSTEMS.

2,750 Machines Sold to Date.

Results Guaranteed.

Prompt Deliveries.

AWARDED SILVER MEDAL, R.A. SHOW, 1904.

H. J. WEST & CO., Ltd.,

114—118, SOUTHWARK BRIDGE ROAD,
LONDON, S.E.

CABLES: "SAXOSUS."
TELEGRAMS: "COPPERWORM."
PHONE: 879 HOP.

Contractors H.M. to Government, War Department, and India Office.

PAGE'S WEEKLY Locomotives, &c.

This illustration is of a Steam Wagon to carry 6 Tons and haul 4 Tons on a Trailer.

THE . .

Yorkshire Patent Steam Wagon Co.

(Branch of Deighton's Patent Flue and Tube Company, Ltd.),

Pepper Road, Hunslet, Leeds.

MAKERS OF

STEAM MOTOR WAGONS

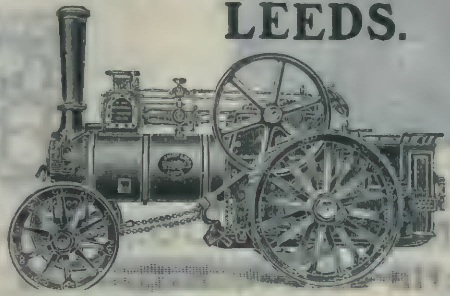
To suit any trade purpose, and to carry 3, 4, 5, and 6 tons.

Full particulars on application.

McLAREN'S Traction Engines, LEEDS.

Cable Address: "McLAREN, LEEDS."

Codes used: A B C 4th and 5th Editions. LIEBER'S.



Catalogues and Pamphlets mailed free on application to—

J. & H. McLAREN, Midland Engine Works, LEEDS.

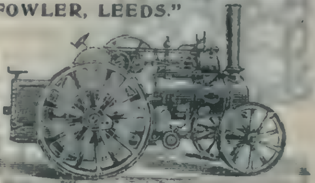
JOHN FOWLER & CO. (Leeds), Ltd.

Steam Plough Works, LEEDS.

Telegrams: "FOWLER, LEEDS."

Manufacturers of

Traction Engines,



Steam Rollers, Portable Railways, &c., &c.

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BROAD AND NARROW GAUGE

Locomotives

SINGLE EXPANSION & COMPOUND

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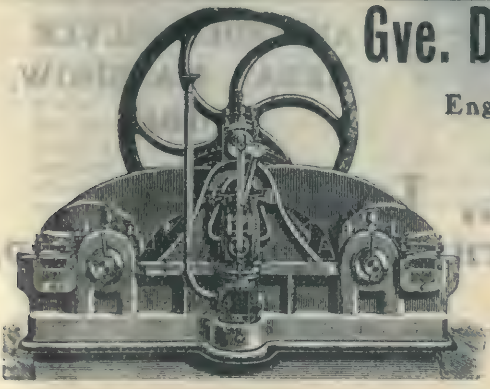
Electric Locomotives with Westinghouse Motors and Electric Trucks.

Burnham, Williams & Co., Philadelphia, Pa., U.S.A.

Cable Addresses: "Baldwin, Philadelphia"; "Sanders, London." General Agents: SANDERS & CO., 110, Cannon St., London, E.C.



Gve. DETOMBAY, Mce. DELANGE & Cie.

Engineering Works, HOBOKEN, near ANTWERP.

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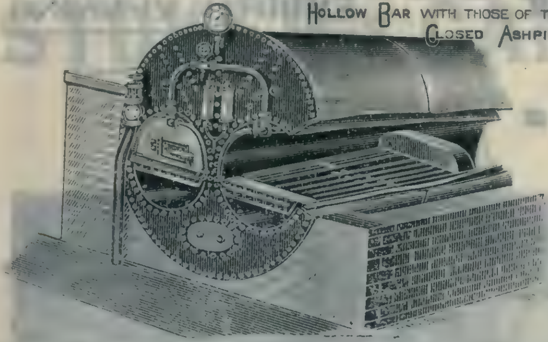
FORCED DRAUGHT.

THE SECTIONAL FORCED DRAUGHT FURNACE

COMBINES ALL THE ADVANTAGES OF THE HOLLOW BAR WITH THOSE OF THE CLOSED ASHPIT



Saving in Fuel,

Even Distribution of Air.

Fire not Blown into Holes.

CAN BE FITTED TO ANY BOILER.

Full Particulars on Application.

The Horsfall Destructor Co., Ltd.,
Armley, LEEDS.

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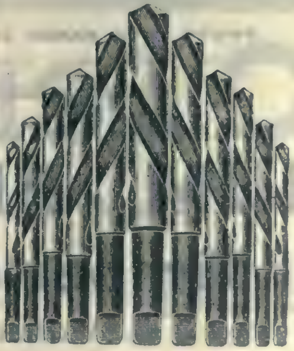

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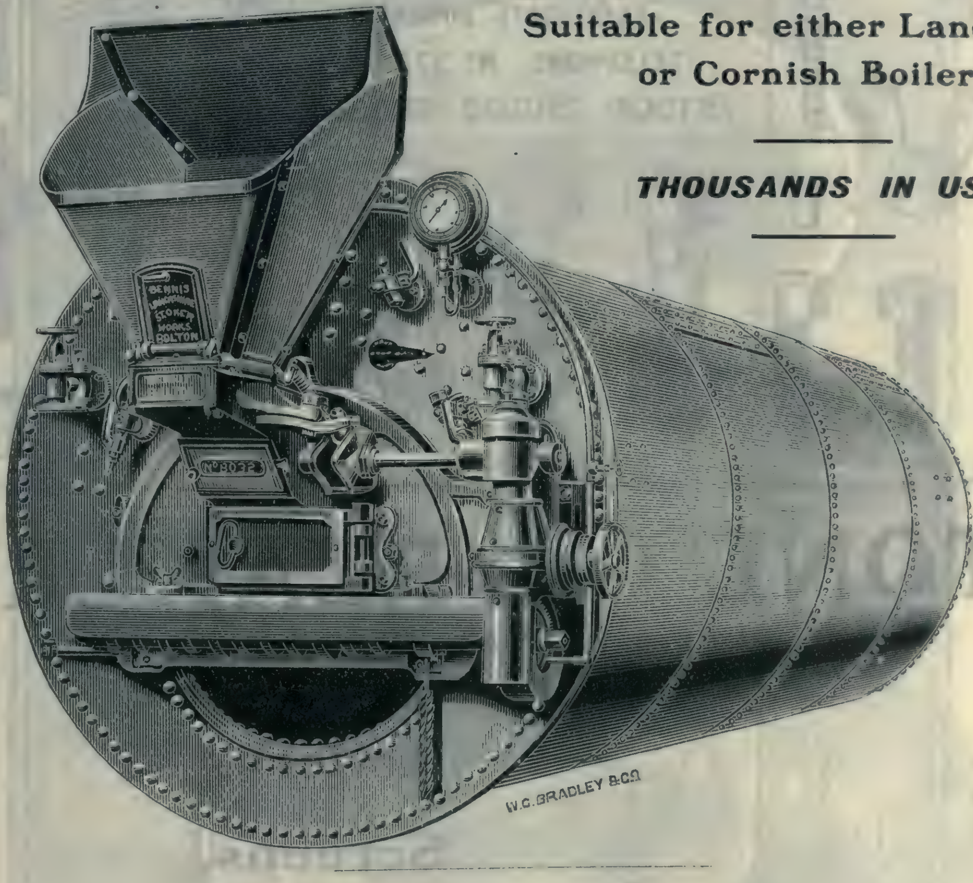

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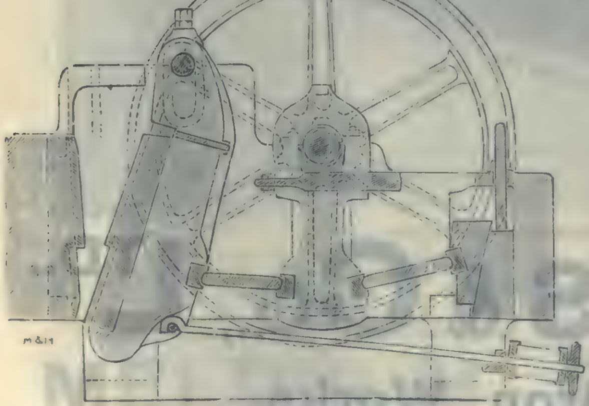

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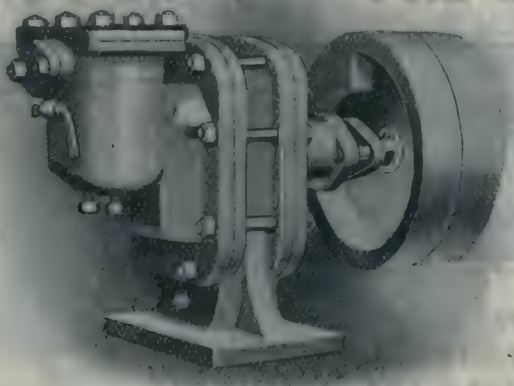

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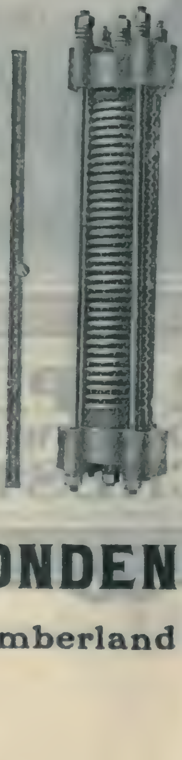

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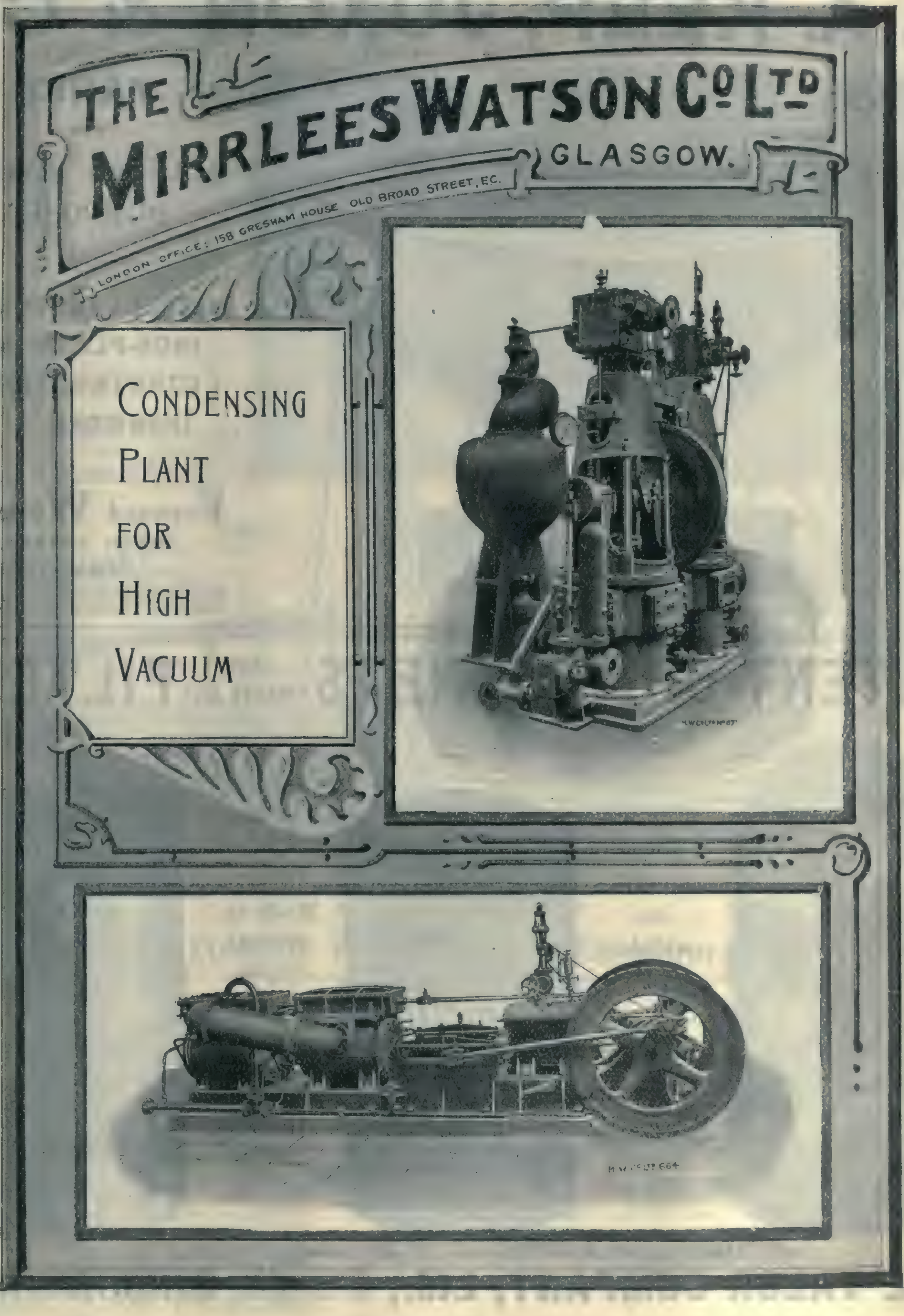

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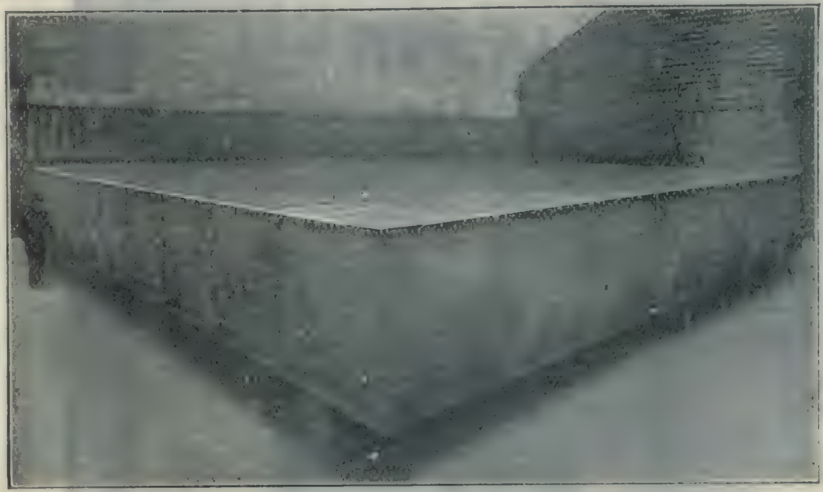

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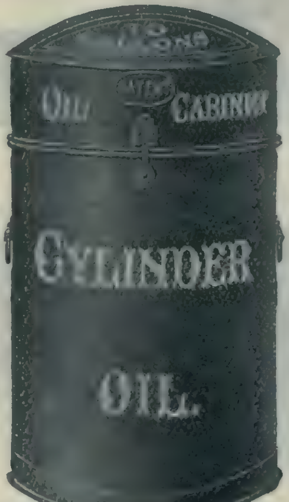

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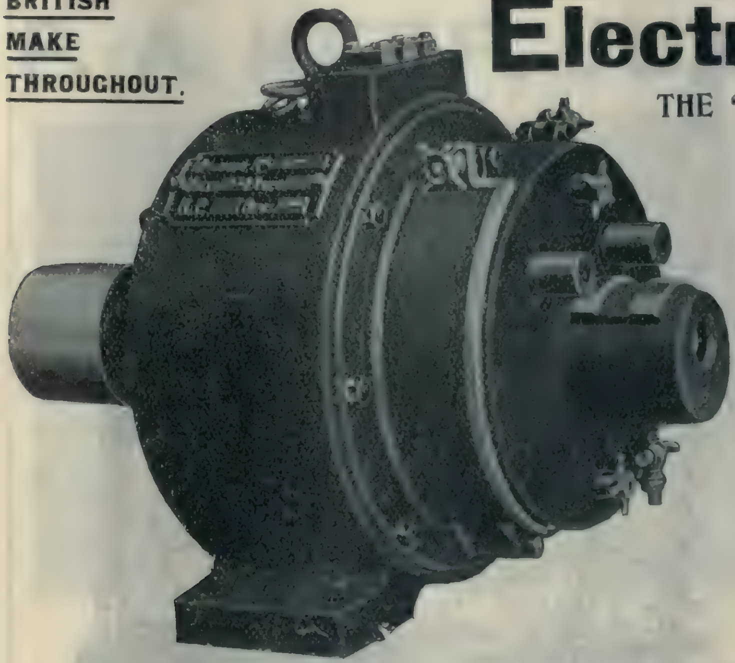

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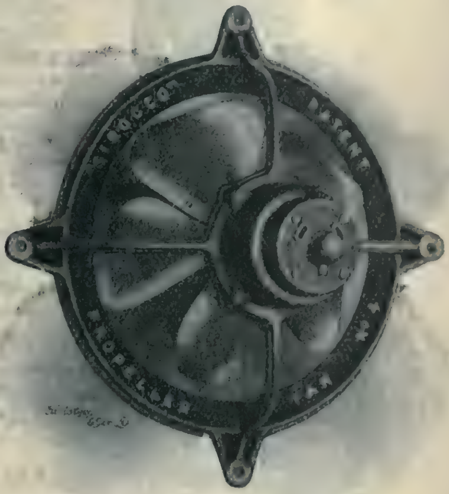

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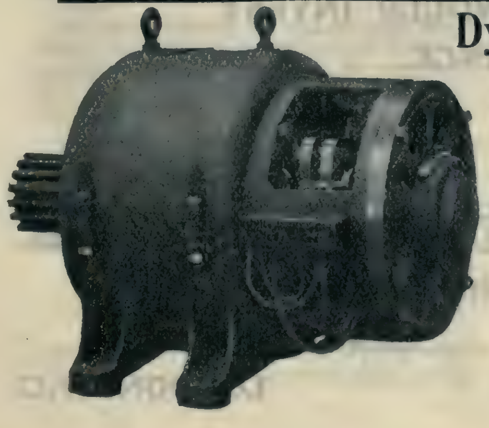

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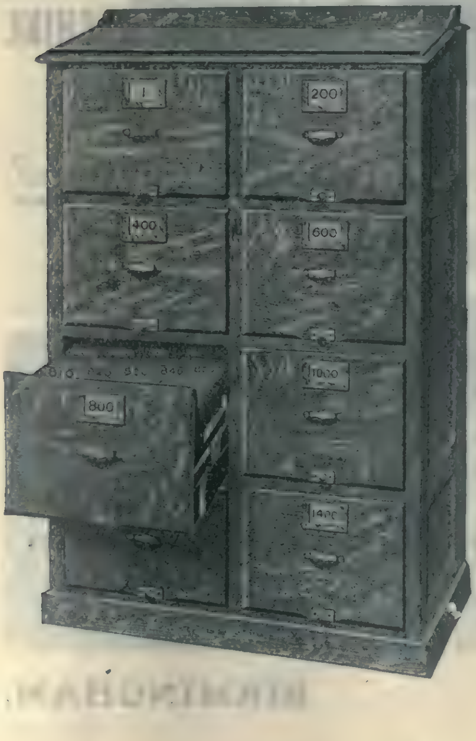

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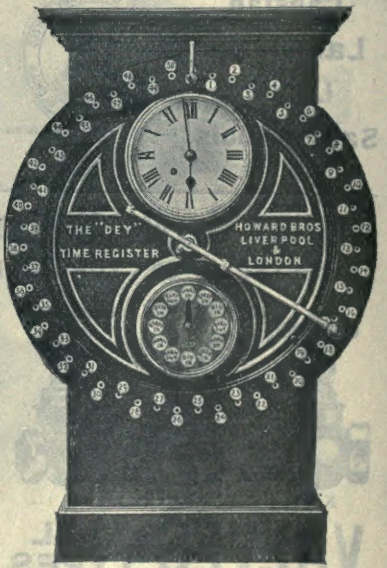

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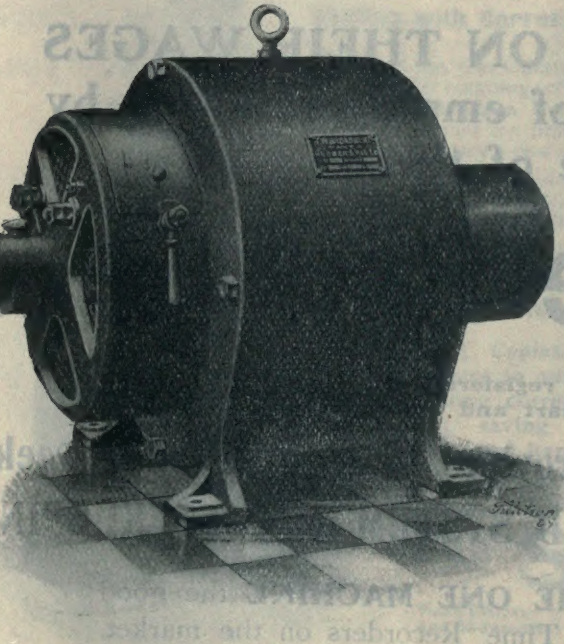

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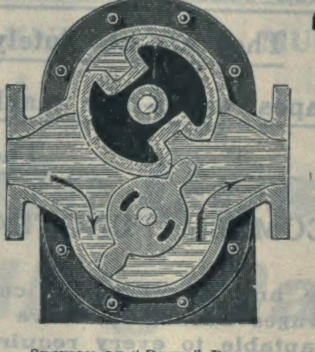

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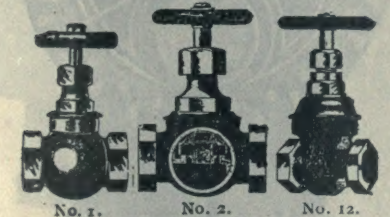

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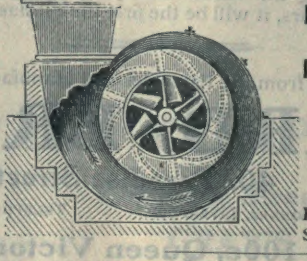

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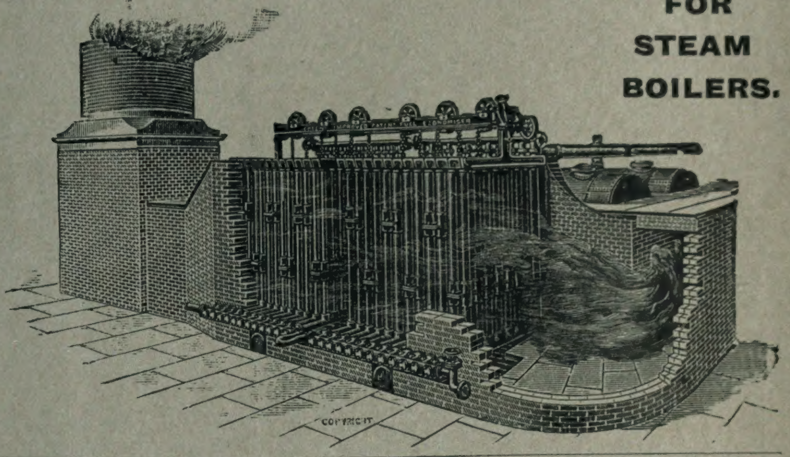

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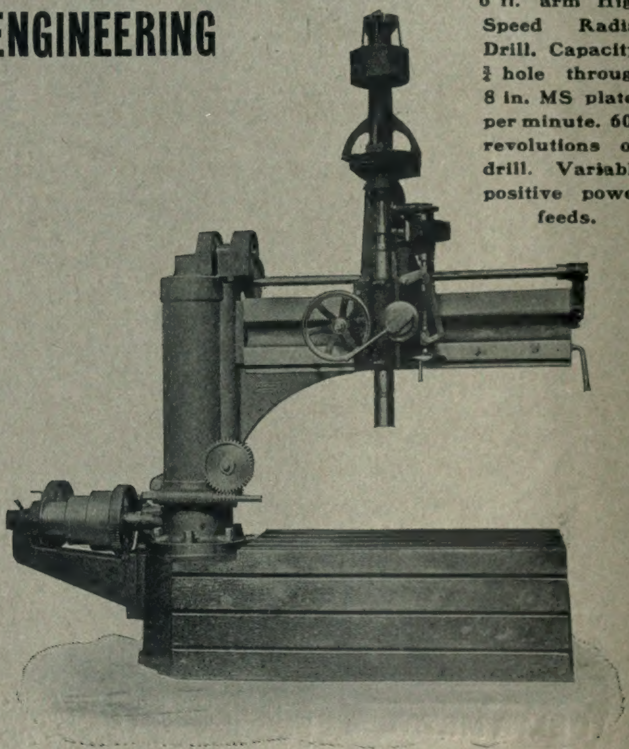

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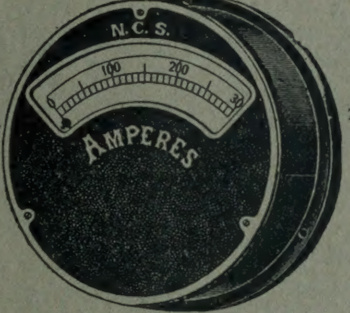

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